/321603.sch
Message 122:
From spo_patent@spo.eds.com Mon Sep 9 14:17:26 1996
Received: from pin1.spo.eds.com (www.spo.eds.com [192.238.49.35]) by pioneer.uspto.gov (8.7.4/8.7.3) with SMTP id OAA23392 for <mayasyst@pioneer.uspto.gov>; Mon, 9 Sep 1996 14:17:19 -0400 (EDT)
From: spo_patent@spo.eds.com
Received: by pin1.spo.eds.com (4.1/spo-1.4)
id AA18802; Mon, 9 Sep 96 13:16:59 CDT
Received: from spo.spo.eds.com by spo1.eds.com (4.1/SPOUUCP-1.8)
id AA13027; Mon, 9 Sep 96 13:12:42 CDT
Received: from spo4.spo.eds.com by spo.spo.eds.com (4.1/SPO-2.5)
id AA05980; Mon, 9 Sep 96 13:12:39 CDT
Date: Mon, 9 Sep 96 13:12:38 CDT
X-Disclaimer: This e-mail is not an official business record of EDS.
To: mayasyst@pioneer.uspto.gov
Sender: spo_patent@spo.eds.com
Subject: Re: 321603.sch
X-Mailer: SPO Mail
Mime-Version: 1.0
Message-Id: <19960909_130323_spo_5912>
Content-Type: text/plain; charset=us-ascii
Status: R

CUSTOMER REQUEST SUMMARY

Your request was:

>e003
>
>Word frequency list for document 321603
>
>---search-id---
>stevens g.
>---search-id---
>
>---word freq---

> 2 ability	7 above	1 abstract
> 6 acceptable	2 accepts	2 accommodate
> 1 accommodates	3 accomplish	12 according
> 1 accuracy	1 accurate	1 accurately
> 1 aciliere	1 acity	1 acquisition
> 3 activities	9 activity	1 actual
> 1 add	6 added	1 addition
> 4 additional	4 additionally	1 additions
> 2 address	1 addressed	1 addressing
> 1 adds	1 adequate	4 adequately
> 2 advantages	1 aed	2 after
> 1 again	2 against	1 aicliael
> 1 aintenarice	5 algorithms	15 all
> 1 allocating	1 allotted	1 allowed
> 1 allowing	1 ally	9 also

> 1 alter	1 alternative	1 amount
> 2 analogous	99 and	1 annealing
> 7 another	4 any	1 applicable
> 1 application	3 applications	5 approach
> 1 approaches	1 approximated	1 arduous
>37 are	1 ariety	1 arrangement
> 1 art	2 assemblies	5 assembly
> 1 assigning	2 assignment	1 assignments
> 3 associated	1 assumes	1 attempt
> 1 attrib	1 attributes	1 automatic
> 1 automatically	2 available	2 backtracking
> 1 bacygp	1 basecl	14 based
> 1 batches	6 because	1 bee
>10 been	2 before	1 begin
> 1 beginning	1 begins	3 being
> 1 below	5 best	5 better
> 2 between	1 bills	1 biological
> 2 boards	1 boms	6 both
> 1 bound	1 branch	2 brian
>11 build	1 but	1 calculated
> 4 calculating	25 can	2 cannot
> 1 cap	40 capacity	5 case
> 1 cases	2 caused	1 causes
> 1 center	1 certain	3 change
> 4 changes	2 changing	1 characteristics
> 1 cheduling	1 choose	1 chosen
> 2 circuit	1 classrooms	1 close
> 1 combine	1 combined	1 comp
> 2 comparison	1 comple	1 complet
> 4 complete	1 completion	13 complex
> 1 complicated	4 component	1 components
> 1 computer	2 computers	2 condition
> 3 conditions	1 conduct	1 configuration
> 1 conflict	1 conflicts	1 conforming
> 1 cons	2 consider	2 consideration
> 1 considers	1 consists	1 constrain
> 3 constrained	29 constraint	60 constraints
> 1 construction	14 constructive	7 consumable
> 1 consumer	1 consumers	1 consuming
> 3 context	1 continue	2 contrast
> 1 converge	2 could	1 couple
> 2 coupled	2 coupling	1 courses
> 5 criteria	1 crossovers	2 crp
>17 current	9 cut	1 dalln
> 1 daun	1 davis	2 deale
> 1 deficiencies	2 define	2 defined
> 2 definition	1 definitions	8 degree
> 2 delete	1 deleted	1 deletions
> 5 demand	5 described	1 description
> 2 desired	2 determination	1 determine
> 2 determined	3 determining	10 develop
> 8 developed	1 developmenr	2 development

> 1 alter	1 alternative	1 amount
> 2 analogous	99 and	1 annealing
> 7 another	4 any	1 applicable
> 1 application	3 applications	5 approach
> 1 approaches	1 approximated	1 arduous
>37 are	1 ariety	1 arrangement
> 1 art	2 assemblies	5 assembly
> 1 assigning	2 assignment	1 assignments
> 3 associated	1 assumes	1 attempt
> 1 attrib	1 attributes	1 automatic
> 1 automatically	2 available	2 backtracking
> 1 bacygp	1 basecl	14 based
> 1 batches	6 because	1 bee
>10 been	2 before	1 begin
> 1 beginning	1 begins	3 being
> 1 below	5 best	5 better
> 2 between	1 bills	1 biological
> 2 boards	1 boms	6 both
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>11 build	1 but	1 calculated
> 4 calculating	25 can	2 cannot
> 1 cap	40 capacity	5 case
> 1 cases	2 caused	1 causes
> 1 center	1 certain	3 change
> 4 changes	2 changing	1 characteristics
> 1 cheduling	1 choose	1 chosen
> 2 circuit	1 classrooms	1 close
> 1 combine	1 combined	1 comp
> 2 comparison	1 comple	1 complet
> 4 complete	1 completion	13 complex
> 1 complicated	4 component	1 components
> 1 computer	2 computers	2 condition
> 3 conditions	1 conduct	1 configuration
> 1 conflict	1 conflicts	1 conforming
> 1 cons	2 consider	2 consideration
> 1 considers	1 consists	1 constrain
> 3 constrained	29 constraint	60 constraints
> 1 construction	14 constructive	7 consumable
> 1 consumer	1 consumers	1 consuming
> 3 context	1 continue	2 contrast
> 1 converge	2 could	1 couple
> 2 coupled	2 coupling	1 courses
> 5 criteria	1 crossovers	2 crp
>17 current	9 cut	1 dalln
> 1 daun	1 davis	2 deale
> 1 deficiencies	2 define	2 defined
> 2 definition	1 definitions	8 degree
> 2 delete	1 deleted	1 deletions
> 5 demand	5 described	1 description
> 2 desired	2 determination	1 determine
> 2 determined	3 determining	10 develop
> 8 developed	1 developmenr	2 development

> 1 develops	6 device	1 different
> 1 difficult	1 dified	1 direct
> 1 directly	2 discussed	2 disk
> 5 dispatching	1 display	1 disruption
> 1 disruptive	1 distribution	1 disturbances
> 8 does	2 done	2 drives
> 1 dule	8 during	1 dynamic
>20 each	1 ear	1 earlier
> 1 ease	3 easily	1 easy
> 1 eben	1 edule	1 efficacy
> 1 effort	1 eil	3 either
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> 6 embodiment	1 enables	1 enabling
> 1 ended	1 ensure	1 enterprise
> 1 entiot	4 entire	1 equipment
> 4 established	1 establishing	1 establishment
> 2 eugene	1 eusable	2 evaluate
> 4 evaluated	1 evaluates	2 evaluation
> 3 even	1 exactly	14 example
> 3 exception	1 execution	1 exhaust
> 1 exhaustive	1 exist	2 existing
> 2 expert	1 exploitation	1 extended
> 1 extensive	1 extensively	2 extent
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> 1 fails	1 failure	1 far
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> 9 finished	3 finite	1 flexible
> 1 flows	55 for	1 forecasted
> 1 formulations	3 found	3 frequent
> 3 frequently	1 fro	12 from
> 1 fulfill	5 function	1 functions
>15 further	1 gene	3 generally
> 3 genetic	5 global	1 good
>11 goods	1 great	1 hand
> 9 has	8 have	1 heduling
> 1 hierarchy	1 higher	4 however
> 1 human	1 iiecess	3 iii
> 1 ilite	1 ill	1 illustrative
> 1 imoditicat	2 implement	1 implemented
> 2 importance	1 improving	1 inclucies
> 2 include	1 included	4 includes
> 2 including	1 incomplete	1 increasingly
> 2 incrementally	1 inevitable	1 infinite
> 1 inflexible	6 information	1 ing
> 1 inished	4 initial	1 initiated
> 6 input	1 int	2 integer
> 1 integrated	1 integrates	1 interring
> 3 into	14 invention	23 inventory
> 1 iplicity	1 iques	1 irl
> 1 ise	1 itate	1 itates
> 1 ite	1 items	2 iterate
> 1 iterates	3 iteration	2 iterations

>16 iterative	3 iteratively	1 itiplicity
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> 2 knowledge	1 known	3 labor
> 1 lar	5 large	1 lead
> 1 leas	1 least	1 lend
> 1 lengthy	6 level	3 levels
> 1 library	2 like	1 limit
> 1 limitation	2 limited	1 line
> 3 linear	1 lines	1 little
> 3 long	4 machine	1 machines
> 2 macrocosmic	6 made	1 make
> 1 makes	4 making	1 manage
> 3 management	1 mance	2 manner
> 1 manufacturer	1 manufacturers	10 manufacturing
> 4 many	5 master	1 matches
> 1 matching	5 material	7 materials
> 5 mathematical	5 may	1 meet
> 1 meets	2 memory	1 merely
> 2 met	30 method	22 methods
> 1 metric	1 michael	1 microcosmic
> 2 milestone	2 minimization	2 minimize
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> 3 modifications	4 modified	3 modify
> 1 monte	10 more	1 most
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> 1 mult	3 multiplicity	10 must
> 1 mutations	1 nature	1 nce
> 1 near	1 necess	2 necessarily
> 5 necessary	3 necessitates	1 necessitating
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> 2 network	3 neural	14 new
> 1 nio	2 none	24 not
> 1 nple	9 number	2 obtain
> 4 obtained	1 occasionally	2 occur
> 1 offered	2 often	1 old
> 3 once	16 one	14 only
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> 6 optimal	7 optimization	1 optimize
> 2 order	2 ordering	1 oreseell
> 9 other	1 ources	1 out
> 3 output	1 outputs	4 over
> 1 overly	2 pai	2 part
>11 partial	5 particular	2 particularly
> 5 parts	1 pelated	3 penalty
> 1 perfect	1 perform	1 performance
> 2 performed	1 performing	1 period
> 1 pert	2 perturbation	3 perturbations
> 1 place	1 placed	2 planner
>40 planning	1 point	1 portion

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> 5 predetermined	2 preemptive	5 previous
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>25 problem	14 problems	1 procedure
> 1 proceed	4 process	1 processes
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> 1 produced	1 produces	1 producing
> 1 product	12 production	8 programming
> 1 progress	1 providing	1 quantity
> 1 questionable	2 quicker	1 quickly
> 3 random	2 rapid	4 rather
> 6 raw	3 reached	3 real
> 1 realm	3 reasoning	1 reconstruct
> 1 reconstructing	1 reducing	1 reformulation
> 1 regard	2 regarding	1 rela
> 2 relates	2 relative	2 relatively
> 5 relaxed	1 relments	3 rely
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> 1 requ	3 require	1 required
>11 requirements	3 requires	2 reschedule
> 3 rescheduled	11 rescheduling	1 resolution
> 2 resolve	2 resolved	13 resource
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> 1 restrictive	1 result	1 ret
> 1 retailers	5 reusable	19 revised
> 1 revisions	2 reworking	1 rity
> 1 robleni	9 rough	1 rsol
> 1 rtic	2 rule	3 rules
> 1 same	1 sand	4 satisfaction
> 2 satisfactory	2 satisfied	2 satisfies
> 4 satisfy	1 satist	1 scheclul
> 1 schedu	99 schedule	3 scheduled
>20 schedules	55 scheduling	13 score
> 1 scoring	3 scratch	1 search
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> 1 semester	1 separately	5 series
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> 1 should	1 shutt	1 significant
> 1 significantly	1 simple	1 simulated
> 5 simulation	8 simultaneously	9 since
> 1 single	1 situation	1 situations
> 1 sive	4 slow	1 slowness
> 1 small	2 smooth	1 sold
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> 1 solved	1 solves	1 solving
> 8 some	1 soule	1 space
> 1 speed	1 ssigning	1 standard
> 2 start	3 state	2 step
> 2 steps	1 storage	1 store

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> 1 subassemblies 1 subassembly 2 subject
> 1 subsequent 1 subset 1 substituted
> 1 succ 2 successive 1 successively
>18 such 2 suffer 3 sufficient
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> 2 supplied 3 supply 1 sutnable
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> 1 take 1 taken 2 takes
> 2 task 19 tasks 1 teachers
> 1 techn 7 techniques 1 ted
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>53 that 99 the 1 them
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> 1 though 1 threshold 4 through
> 5 thus 10 time 7 times
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> 3 two 3 type 2 types
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> 1 undesirably 1 university 7 until
> 3 upon 1 usage 9 use
>20 used 4 useful 2 user
> 4 uses 5 using 1 usually
> 1 utes 1 value 1 valued
> 2 variables 1 variation 2 various
> 1 vary 1 veloped 1 veritioll
> 3 very 1 ves 1 vii
> 1 viii 2 violate 2 violated
> 1 violates 8 violation 4 violations
> 1 voluminous 1 ways 2 weak
> 1 weekends 3 weight 2 well
> 3 when 3 where 3 whether
> 4 which 1 while 1 who
> 1 wide 5 will 18 with
> 1 without 1 wllic 1 words
> 2 work 2 workers 2 world
> 1 worse 1 xarti 1 zweben
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>abstracts
>exemplary claims
>field of search 50

>titles
>---output options---
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Sales Order Summary:
Customer ID: 681
Sales Transaction Nbr: 19618
Date Posted: September 9, 1996
Product: E003
Quantity: 50

E003 WORD FREQUENCY SEARCH REPORT

Top Referenced Classes:

1. 364/468 Total=20 ORs=12 XRs=8
   Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
   Sub 400 APPLICATIONS
   Sub 468 .Product manufacturing

2. 364/401 R Total=18 ORs=6 XRs=12
   Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
   Sub 400 APPLICATIONS
   Sub 401 R .Business practice or management

3. 364/402 Total=16 ORs=12 XRs=4
   Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
   Sub 400 APPLICATIONS
   Sub 401 R .Business practice or management
   Sub 402 ..Operations research

4. 395/11 Total=9 ORs=2 XRs=7
   Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
   Sub 1 ARTIFICIAL INTELLIGENCE
   Sub 10 .Knowledge processing
   Sub 11 ..Plural processing systems

5. 364/DIG. 1 Total=8 ORs=0 XRs=8
   Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
   Sub DIG. 1 GENERAL PURPOSE PROGRAMMABLE DIGITAL COMPUTER SYSTEMS

6. 395/906 Total=7 ORs=0 XRs=7
   Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
   Sub 902 APPLICATIONS USING AI WITH DETAILS OF THE AI SYSTEM
   Sub 903 .Control
   Sub 906 ..Process plants

7. 364/DIG. 2 Total=5 ORs=0 XRs=5
   Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
   Sub DIG. 2 GENERAL PURPOSE PROGRAMMABLE DIGITAL COMPUTER

SYSTEMS

8. 395/12 Total=5 ORs=1 XRs=4
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 1 ARTIFICIAL INTELLIGENCE
Sub 10 .Knowledge processing
Sub 12 ..Graphical or natural language user interface

9. 395/68 Total=5 ORs=1 XRs=4
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 1 ARTIFICIAL INTELLIGENCE
Sub 10 .Knowledge processing
Sub 50 ..Expert systems
Sub 60 ...Knowledge representations
Sub 68 ....History base

10. 395/914 Total=5 ORs=0 XRs=5
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 902 APPLICATIONS USING AI WITH DETAILS OF THE AI SYSTEM
Sub 911 .Nonmedical diagnostics
Sub 914 ..Process plants

11. 364/221.9 Total=4 ORs=0 XRs=4
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.2 APPLICATIONS
Sub 221.9 .Process control

12. 364/281.8 Total=4 ORs=0 XRs=4
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.16 SYSTEM MANAGEMENT (SOFTWARE)
Sub 280 .Operating system
Sub 281.3 ..Process (task) management
Sub 281.8 ...Scheduling

13. 395/51 Total=4 ORs=1 XRs=3
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 1 ARTIFICIAL INTELLIGENCE
Sub 10 .Knowledge processing
Sub 50 ..Expert systems
Sub 51 ...Deduction, control, or search techniques

14. 395/650 Total=4 ORs=4 XRs=0
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 650 PROCESSING (TASK) MANAGEMENT

15. 395/904 Total=4 ORs=0 XRs=4
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 902 APPLICATIONS USING AI WITH DETAILS OF THE AI SYSTEM
Sub 903 .Control
Sub 904 ..Manufacturing or machines (e.g., agricultural machinery, machine tools, robots)

16. 395/926 Total=4 ORs=0 XRs=4
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 902 APPLICATIONS USING AI WITH DETAILS OF THE AI SYSTEM
Sub 925 .Business
Sub 926 ..Time management

17. 364/148 Total=3 ORs=1 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 130 DATA PROCESSING CONTROL SYSTEMS, METHODS OR APPARATUS
Sub 148 .Optimization or adaptive control

18. 364/156 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 130 DATA PROCESSING CONTROL SYSTEMS, METHODS OR APPARATUS
Sub 148 .Optimization or adaptive control
Sub 152 ..Specific criteria of system performance
Sub 153 ...Constraints or limits (e.g., max/min)
Sub 156 ....Economic (e.g., cost)

19. 364/274 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.15 ARTIFICIAL INTELLIGENCE
Sub 274 .Artificial intelligence (AI)

20. 364/274.2 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.15 ARTIFICIAL INTELLIGENCE
Sub 274 .Artificial intelligence (AI)
Sub 274.1 ..Software
Sub 274.2 ...Expert system

21. 364/274.3 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.15 ARTIFICIAL INTELLIGENCE
Sub 274 .Artificial intelligence (AI)
Sub 274.1 ..Software
Sub 274.2 ...Expert system
Sub 274.3 ....Knowledge base

22. 364/274.5 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.15 ARTIFICIAL INTELLIGENCE
Sub 274 .Artificial intelligence (AI)
Sub 274.1 ..Software
Sub 274.2 ...Expert system
Sub 274.3 ....Knowledge base
Sub 274.5 .....Rule based

23. 364/281.3 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS

Sub ???.16 SYSTEM MANAGEMENT (SOFTWARE)
Sub 280 .Operating system
Sub 281.3 ..Process (task) management

24. 364/282.1 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.16 SYSTEM MANAGEMENT (SOFTWARE)
Sub 282.1 .Data base

25. 364/972.3 Total=3 ORs=0 XRs=3
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.26 PROGRAMMING SYSTEMS
Sub 972 .Artificial intelligence
Sub 972.2 ..Expert system
Sub 972.3 ...Rule based

26. 379/221 Total=3 ORs=0 XRs=3
Class 379 TELEPHONIC COMMUNICATIONS
Sub 219 PLURAL EXCHANGE NETWORK OR INTERCONNECTION
Sub 220 .With interexchange network routing
Sub 221 ..Alternate routing

27. 340/827 Total=2 ORs=0 XRs=2
Class 340 COMMUNICATIONS: ELECTRICAL
Sub 825 SELECTIVE
Sub 825.03 .Channel selection
Sub 826 ..Plural stage matrix system (e.g., path finding)
Sub 827 ...Alternate routing

28. 364/138 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 130 DATA PROCESSING CONTROL SYSTEMS, METHODS OR APPARATUS
Sub 138 .Supervisory control

29. 364/149 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 130 DATA PROCESSING CONTROL SYSTEMS, METHODS OR APPARATUS
Sub 148 .Optimization or adaptive control
Sub 149 ..With model

30. 364/228.3 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.4 SYSTEM ARCHITECTURE
Sub 228.3 .Plural (redundant) central processors

31. 364/232.7 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.4 SYSTEM ARCHITECTURE
Sub 232.7 .Modular

32. 364/237.2 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.5 INPUT/OUTPUT DEVICES
Sub 237.2 .Display

33. 364/237.3 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.5 INPUT/OUTPUT DEVICES
Sub 237.2 .Display
Sub 237.3 ..Cathode-ray tube (CRT)

34. 364/274.7 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.15 ARTIFICIAL INTELLIGENCE
Sub 274 .Artificial intelligence (AI)
Sub 274.1 ..Software
Sub 274.2 ...Expert system
Sub 274.7 ....Rule interpreter/inference engine

35. 364/276.1 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.15 ARTIFICIAL INTELLIGENCE
Sub 274 .Artificial intelligence (AI)
Sub 274.1 ..Software
Sub 275.1 ...Application
Sub 276.1 ....Planning

36. 364/281.6 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.16 SYSTEM MANAGEMENT (SOFTWARE)
Sub 280 .Operating system
Sub 281.3 ..Process (task) management
Sub 281 ...Load balancing
Sub 281.6 ....Resource allocation

37. 364/286 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.16 SYSTEM MANAGEMENT (SOFTWARE)
Sub 286 .Program management

38. 364/286.1 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.16 SYSTEM MANAGEMENT (SOFTWARE)
Sub 286 .Program management
Sub 286.1 ..Prompting

39. 364/408 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 400 APPLICATIONS
Sub 401 R .Business practice or management
Sub 408 ..Finance (e.g., securities, commodities)

40. 364/478 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 400 APPLICATIONS
Sub 478 .Article handling or distribution

41. 364/500 Total=2 ORs=1 XRs=1
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 400 APPLICATIONS
Sub 496 .Chemical and engineering sciences
Sub 500 ..Chemical process control

42. 364/550 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 550 MEASURING, TESTING, OR MONITORING

43. 364/578 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub 550 MEASURING, TESTING, OR MONITORING
Sub 570 .Operations performed
Sub 578 ..Simulation or modeling

44. 364/972 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.26 PROGRAMMING SYSTEMS
Sub 972 .Artificial intelligence

45. 364/972.2 Total=2 ORs=0 XRs=2
Class 364 ELECTRICAL COMPUTERS AND DATA PROCESSING SYSTEMS
Sub ???.26 PROGRAMMING SYSTEMS
Sub 972 .Artificial intelligence
Sub 972.2 ..Expert system

46. 379/113 Total=2 ORs=0 XRs=2
Class 379 TELEPHONIC COMMUNICATIONS
Sub 111 WITH USAGE MEASUREMENT (E.G., CALL OR TRAFFIC REGISTER)
Sub 112 .Computer or processor control
Sub 113 ..Call traffic recording

47. 395/10 Total=2 ORs=0 XRs=2
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 1 ARTIFICIAL INTELLIGENCE
Sub 10 .Knowledge processing

48. 395/50 Total=2 ORs=2 XRs=0
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 1 ARTIFICIAL INTELLIGENCE
Sub 10 .Knowledge processing
Sub 50 ..Expert systems

49. 395/62 Total=2 ORs=0 XRs=2
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION

Sub 1 ARTIFICIAL INTELLIGENCE
Sub 10 .Knowledge processing
Sub 50 ..Expert systems
Sub 60 ...Knowledge representations
Sub 62 ....Objects (i.e., object-attribute-value), frames and slots, or scripts

50. 395/925 Total=2 ORs=0 XRs=2
Class 395 INFORMATION PROCESSING SYSTEM ORGANIZATION
Sub 902 APPLICATIONS USING AI WITH DETAILS OF THE AI SYSTEM
Sub 925 .Business

Top closest patents:

Ref	Patent Id	Issue/File	Class	Title
1	05216593	Jun 1 1993 Jan 24 1991	364/402	Method and apparatus for discrete activity resourse allocation through cardinality constraint generation

Inventor: Dietrich; Brenda L. et al.
Assignee: International Business Machines Corporation
Abstract:

The required computational effort in the areas of production planning and logistics, scheduling, distribution and resource allocation is reduced by a procedure for solving a Discrete Activity Resource Allocation (DARA) problem. The procedure begins by reducing all activities and resources which do not contribute to maximizing benefit. Thus, all infeasible and non-profitable activities are discarded and all non-constraining resources are discarded, thereby considerably simplifying the solution to the problem. Next, an automatic mathematical model formulation of the DARA problem is performed. Based on this model, a list of cliques and covers are generated. The linear relaxation of the DARA problem using standard linear programming software is solved, and the generated list of clique and cover induced inequalities is scanned to select a set violated by the solution of the linear relaxation of the DARA problem. For those inequalities found, constraints are appended to the formulated DARA problem, forming another DARA problem with the same set of variables, but with additional constraints. The new DARA problem is then solved using the previous solution as the start of the solution. Based on this solution, the generated list of clique and cover induced inequalities is again scanned, and this process is continued until no violated inequalities are found. At this point in the procedure, conventional branch-and-bound or branch-and-cut routines are used to solve the enlarged DARA problem. The solution yields the optimal resource allocation producing the maximum benefit.

Exemplary Claim [1]:

1. A computer based system for discrete activity resource allocation in the manufacture of large, indivisible or highly customized products comprising:

order entry/tracking means for collecting orders and maintaining a

list of all outstanding orders;

a bill of materials database and a machine/manpower requirements database;

bill of material explosion means responsive to said order entry/tracking means for accessing said bill of materials database and transforming said orders into raw material requirements;

machine requirements explosion means responsive to said order entry/tracking means for accessing said machine/manpower requirements database and determining machine and manpower requirements of each order;

inventory sensor means for determining available quantity of raw material;

shop floor sensor means for determining availability of machines and manpower;

profit analyzer means responsive to said order entry/tracking means, said bill of material explosion means and said machine requirements explosion means for determining a profit associated with each order;

data preprocessing means responsive to said inventory sensor means, said shop floor sensor means and said profit analyzer means for eliminating orders that cannot be produced and resources that will not affect order selection;

model generator means responsive to said data preprocessing means for mathematically modeling consumption of resources by orders and an availability of resources;

cardinality constraint generator means responsive to said model generator means for determining simple choices implied by a mathematical model generated by said model generator means; and

interactive decision display means for displaying to a user choices generated by said cardinality constraint generator means to assist the user in deciding which orders to make and receiving from the user selection and rejection of orders, said interactive decision display means further providing inputs to said order entry/tracking means and said data preprocessing means based on said user selection and rejection of orders.

2 05432887 Jul 11 1995 395/11 Neural network system and method
Mar 16 1993 for factory floor scheduling

Status: certificate of correction has been issued

Inventor: Khaw; Fook C.

Assignee: Singapore Computer Systems

Abstract:

Methods are developed on a digital computer for performing work order scheduling activity in a dynamic factory floor environment, in a manner which enables scheduling heuristic knowledge from a scheduler to be encoded through an adaptive learning process, thus eliminating the need to define these rules explicitly. A sequential assignment paradigm incrementally builds up a final schedule from a partial schedule, assigning each work order to appropriate resources in turns, taking advantage of the parallel processing capability of neural networks by selecting the most appropriate resource combination (i.e. schedule generation) for each work order under simultaneous interaction of multiple scheduling constraints.

Exemplary Claim [20]:

20. A computer neural network scheduling system adapted for scheduling

of a manufacturing resource on a factory floor, the scheduling process producing a schedule for a sorted list of work orders given the manufacturing resource having at least one machine, the computer neural network scheduling system comprising:

a first neural network, comprising a scheduling knowledge base, for predicting possible schedules for said sorted list of work orders in accordance with a capacity of said manufacturing resource and a first set of weights;

a second neural network, responsive to said first neural network, for producing a schedule in accordance with said sorted list of work orders and said capacity of said manufacturing resource and in accordance with a second set of weights;

a constraint relaxation module for relaxing constraints by adjusting said second set of weights in the event of unsuccessful assignment of a work order;

first connections for connecting an input layer of said first neural network and an output layer of said second neural network;

a first determination mechanism for setting up weights of said first connections in accordance with a work order from said sorted list of work orders and in accordance with said capacity of said manufacturing resource prior to scheduling of said work order;

a second determination mechanism for updating said weights of said first connections in accordance with output of said second neural network after scheduling of said work order; and

second connections, between an output layer of said first neural network and an output layer of said second neural network, for propagating said possible schedules to said second neural network.

3 05040123 Aug 13 1991 364/468 Expert system scheduler
Sep 8 1989

Status: expired - failure to pay first maintenance fee

Inventor: Barber; Karon A. et al.

Assignee: General Motors Corporation

Abstract:

An expert system scheduler is disclosed which uses heuristics developed by an experienced factory scheduler. The scheduler uses these heuristics to generate schedules. Forward and backward scheduling is used at different stages of the schedule generation process.

Exemplary Claim [1]:

1. A computer implemented method of scheduling a plurality of machine operations in a predetermined sequence in a factory containing a plurality of machines and a factory control system which controls the machines in accordance with the schedule, comprising the steps of:

a. constructing a computer model of the factory comprising data relating to the production of parts including inventory, operations, machines, and at least one customer order,

b. scheduling the machine operations necessary to produce the parts in the customer order in the reverse order of routing with the last operation being scheduled first and the first operation being scheduled last,

c. modifying the schedule defined in scheduling step b. by removing machine operations which are unnecessary due to existing factory part inventory to thereby better utilize available machine capacity,

d. further modifying the schedule produced in schedule modifying step c. by shifting certain operations forward in time to insure that no operations are scheduled prior to a predetermined build context time.

4 05369570 Nov 29 1994 364/401 R Method and system for continuous
Nov 14 1991 integrated resource management

Inventor: Parad; Harvey A.

Abstract:

A method for continuous real-time management of heterogeneous interdependent resources is described. The method preferably comprises using multiple distributed resource engines to maintain timely and precise schedules, and action controls, and identifying and responding to rapidly changing conditions in accord with predetermined requirements, relationships, and constraints. Each resource engine continuously adjusts schedules in response to changing status, resource requirements, relationships and constraints. Each action control maintains an ordered list of conditions requiring action, determines the best action in each case, and generates appropriate responses. Preferably methods for continuous operation include inquiring about status concurrent with scheduling activity and recognizing the effects of time passage on the condition of schedules.

Exemplary Claim [1]:

1. A method for continuous resource management of events for a multitude of predetermined heterogenous resources with complex interrelationships by scheduling and controlling actions, said method comprising:

(a) providing memory for permanent and temporary data files;

(b) providing a resource engine for each predetermined resource for continuously performing prospective scheduling;

(c) providing an action control for each management function;

(d) providing a router;

(e) providing a processing unit for operating the resource engine, the action control and the router;

(f) providing into the memory information about each resource comprising resource characteristics, rules for resource use, and relationships with other resources for permanent data files;

(g) initializing the resource engine with independent demand and current conditions;

(h) continuously monitoring with the resource engine changes in independent demand and conditions using data from external agents and providing instructions to an action control; and

(i) using the action control to determine actions to be taken based on resource information and changes and providing instructions to a resource engine;

(j) the router managing, logging and certifying delivery of instructions from and between resource engines, action controls, and external agents;

wherein the temporary data files are used by the resource engine and the action control to store temporary data.

5 05093794 Mar 3 1992 364/468 Job scheduling system
Aug 22 1989

Inventor: Howie; George R. et al.
Assignee: United Technologies Corporation
Abstract:
An improved job scheduling system provides for scheduling of a variety of jobs without special purpose coding by the use of time maps to maintain current data, including the preferred path through the shop, as well as scheduling jobs around bottleneck shop resources in a dynamic manner.
Exemplary Claim [1]:
1. In a shop having a number of shop resources for doing jobs by performing operations on workpieces, each workpiece following a path through at least two shop resources, said path being specified by a work order schedule list characteristic of said job and maintained within computing means and specifying the sequence, location and time of a predetermined set of operations on a workpiece in a predetermined set of at least two shop resources, said computing means including a data processing system comprising WOM means for scheduling operations in at least two shop resources, based on data received from a resource set of at least two BRO means, each BRO means being associated with a shop resource, the method of ordering a work order schedule list for at least one job in a shop, in which:

for at least one job, said WOM means passes a call specifying an initial resource operation for said job to an initial relevant BRO sub set of at least one BRO means for an initial resource operation;

for said initial resource operation at least one BRO means returns a bid to said WOM means specifying at least one suggested time slot for said initial resource operation associated with that BRO means, thereby forming a set of suggested time slots for each resource for said initial resource operation;

said WOM means selects one bid for said initial resource operation in accordance with a predetermined strategy, thereby scheduling an operation time for said selected initial resource operation;

said WOM means then repetitively passes calls to a subsequent relevant BRO sub set of at least one BRO means for each other operation in said predetermined set of operations and selects bids returned from said subsequent relevant BRO set, thereby defining a set of scheduled time slots for said at least one job; and

said computer means then calculates a completion date for said job, characterized in that:

said method of ordering a work order schedule, including said steps of defining a set of scheduled time slots, is performed in a planning mode;

said set of scheduled time slots are contained within a corresponding set of contract time slots having an extent in time at least as great as said set of scheduled time slots and a first BRO means reacts in an operations mode to shop events occurring in its associated shop resource by moving a scheduled operation time within a corresponding first contract time slot from an ineligible scheduled time slot to an eligible time slot, whereby for a first class of shop events said BRO means can adjust the operations of said associated shop resource without affecting the operations of other shop resources or of other jobs; and

for shop events having a schedule impact greater than the extent of said first contract time slot, said system causes that BRO means associated with the next operation in said work order schedule list to

move the scheduled time slot of said next operation within its corresponding contract time slot, whereby for a second class of shop events the execution of other jobs is not affected; and for shop events having a schedule impact greater than the extent of the contract time slots of associated BRO means, said system identifies a conflict set of jobs affected by said shop event and causes said WOM means to pass calls to and select bids from those BRO means associated with operations in said conflict set, whereby said system reschedules those jobs affected by said shop event.

6 05285392 Feb 8 1994 364/468 Parallel manufacturing system
Nov 27 1991
Status: certificate of correction has been issued
Inventor: Kyle; Donald W. et al.
Assignee: McKinsey & Company, Inc.
Abstract:

A parallel manufacturing system for use in a manufacturing plant that utilizes a massively parallel computer determines the scheduling of all manufacturing operations used in connection with the manufacture of the products made in the plant. The system utilizes an explosion procedure to determine the net requirements for all components used in the manufacturing operations, and then schedules any manufacturing operations necessary to make the required components.

Exemplary Claim [16]:

16. A method for use in a manufacturing plant, said method comprising the steps of:

(a) generating manufacturing data representing the relationship between a product and number of components used in the manufacture of said product;

(b) distributing said manufacturing data generated in said step (a) among a plurality of parallel processors in a massively parallel computer; and

(c) using said manufacturing data to determine the number of said components that must be manufactured to produce a quantity of said product.

7 05408663 Apr 18 1995 395/650 Resource allocation methods
Nov 5 1993
Status: certificate of correction has been issued
Inventor: Miller; Harold R.
Assignee: Adrem Technologies, Inc.
Abstract:

Methods of operating a digital computer to optimize project scheduling. Where the overall effects of a schedule, such as total project duration or cost, are unsatisfactory, the schedule is processed iteratively so that on each iteration a particular task is selected for modification according to a preset policy and data defining an aspect of that task is adjusted in a small step. A schedule is further optimized to fit the available resources by a repetitive process of assigning resources having the proper capabilities to tasks according to a predetermined order of tasks and testing whether the assigned resource can permit shortening of the task duration. Further methods select an optimum mix of

capabilities to be provided by each of several resources to be hired for a project.

Exemplary Claim [1]:

1. A computer-implemented method of scheduling tasks constituting a project comprising the steps of:

(a) providing input signals in a computer representing the tasks constituting the project, the dependencies of said tasks on one another and data defining the duration of each said task;

(b) processing said input signals in said computer to calculate an initial set of schedule data which forms an initial schedule including an initial set of times for each said task including earliest starting and latest ending times and an initial subset of said tasks constituting a critical path and providing initial data signals representing said initial set of schedule data;

(c) calculating at least one effect parameter for said initial schedule by processing said initial data signals in said computer to produce an effect parameter signal in said computer;

(d) providing an effect criterion signal in said computer and comparing each said effect parameter to a corresponding effect criterion by processing said effect parameter signal and said effect criterion signal in said computer to determine if each said criterion is met;

(e) if any effects criterion is not met, revising said data by:

(1) automatically applying a preset selection policy set forth in a selection policy signal to the schedule to select a task for modification and a preset modification policy to adjust the input data for the so-selected task stepwise and providing adjusted input signals in said computer;

(2) recalculating said schedule data by reprocessing said adjusted input data signals to thereby provide recalculated schedule data in recalculated data signals;

(3) recalculating said at least one effect parameter based upon said recalculated schedule data; and

(f) repeating said comparing and revising steps until said at least one effect parameter meets said corresponding effect criterion.

8 05212791 May 18 1993 395/650 Dynamic scheduling
Jul 27 1992

Inventor: Damian; Richard G. et al.

Assignee: International Business Machines Corporation

Abstract:

The invention provides a new production scheduling system. The system includes a technique that utilizes a knowledge base system to dynamically schedule production of parts on a plurality of manufacturing machines. The schedule is updated dynamically to conserve synergism with the changing plant environment. The schedule is created to conform with predefined rules to conserve constraints imposed by the machinery to create parts of different specifications. The rules may be hard in that they may be specifiable in mathematical terms or they may be heuristic and soft in that they may be allowed to be relaxed as determined by operators who have learned from experience with the production machinery. Finally, the invention allows interactive monitoring and adjustment of the schedule by an operator including selective seeding of the schedule.

Exemplary Claim [1]:

1. A method for operating a computer system to generate a schedule for a plurality of orders, the schedule having a plurality of slots for orders, the system having an inference engine for processing a set of rules including disposition, strategy and error detection rules, having a production memory for storing the set of rules and having working memory for storing a pool of schedules, comprising the steps of:

(a) forming a current parent schedule in the pool in the working memory having a first slot filled by an order by processing predetermined strategy rules using the inference engine;

(b) generating in the pool in the working memory all possible child schedules for the current parent schedule with each child schedule having at least one more slot filled than the current parent schedule by processing a rule using the inference engine;

(c) calculating error counts for the child schedules which violate the error detection rules by processing the error detection rules using the inference engine;

(d) deleting the current parent schedule from the pool in the working memory by processing a rule using the inference engine;

(e) deleting from the pool in the working memory the child schedules having error counts exceeding a predetermined error count threshold by processing the disposition rules using the inference engine;

(f) determining by processing a rule using the inference engine whether there are any schedules in the pool in the working memory and selecting, by processing a rule using the inference engine, a schedule in the pool, if any exists, as the current parent schedule while leaving the remaining schedules in the pool or ending if there are no schedules in the pool; and

(g) repeating steps (b) through (f) until a schedule with all slots filled is found which meets the disposition rules by processing a rule using the inference engine.

9 05353229 Oct 4 1994 364/468 System, utilized in scheduling, or
Oct 30 1992 the like, for satisfying
constraints by allowing relaxation
of constraints

Inventor: Tanaka; Toshikazu
Assignee: Kabushiki Kaisha Toshiba
Abstract:

In a system, utilized in, e.g., scheduling, for satisfying constraints by allowing relaxation of constraints, a constraint relaxation necessity detection section detects necessity of constraint relaxation in a problem solving cycle of a problem solving section. When the necessity of constraint relaxation is detected, a relaxation target constraint selection section is enabled to select a constraint to be relaxed from a constraint group. A constraint relaxation section searches a constraint relaxation knowledge management section in association with the selected constraint to check if a partial solution satisfies a relaxation permission condition. If the relaxation permission condition is satisfied, constraint relaxation is attempted according to a relaxation method recorded in correspondence with the relaxation permission condition. When the constraint relaxation is executed, the constraint relaxation necessity

detection section checks if the constraint relaxation is successful, and the control returns to the problem solving cycle of the problem solving section.

Exemplary Claim [1]:

1. A system, utilized in scheduling, for satisfying constraints by allowing relaxation of constraints, comprising:

means for obtaining a final solution which specifies values that all variables can assume by repeating a problem solving cycle consisting of generation of a partial solution which refines values that some or all constraints of a constraint group can assume, and a test of checking whether or not the generated solution satisfies each of the constraints;

constraint relaxation necessity detection means for detecting necessity of relaxation of some constraints during execution of the problem solving cycle;

constraint relaxation knowledge management means for managing stored information associated with a possibility of relaxation and a method of relaxation, and a procedure to be enabled to know a relaxation condition from an external source in correspondence with each of the constraints;

relaxation target constraint selection means for, when said constraint relaxation necessity detection means detects the necessity of relaxation of some constraint, selecting a constraint to be relaxed from the constraint group; and

constraint relaxation means for checking the possibility of relaxation of the constraint selected by said relaxation target constraint selection means upon reception of information stored in said constraint relaxation knowledge management means, and for, when it is determined that relaxation is possible, executing relaxation of the constraint.

10 05524077 Jun 4 1996 364/402 Scheduling method and system
Dec 4 1989

Inventor: Faaland; Bruce H. et al.

Abstract:

This invention provides a method and system for cost-based resource scheduling. This invention develops an initial resource schedule. This schedule is then represented as a Schedule Precedence Graph, which is an acyclic directed graph consisting of nodes and arcs. Each node corresponds to a task to be performed, and each arc corresponds to a technological or assigned task precedence. Each node is assigned a cost, which corresponds to cost or savings due to delaying the task one time unit. In this invention, the Maximum Flow Procedure is iteratively invoked to determine which tasks can be profitably delayed.

Exemplary Claim [2]:

2. A method for reallocating a combination of workers, tasks, and work centers based on an initial allocation schedule, each task having an associated start time and an associated inventory carrying cost, each end-product task having an associated delayed delivery cost whereby the start of at least two tasks are delayed when the delayed delivery cost of at least one end-product task is offset by the inventory carrying cost savings due to delaying the start of other tasks, the method comprising the steps of:

developing a Technological Precedence Graph based on product design, whereby the Technological Precedence Graph includes a plurality of nodes

representing tasks and directed arcs connecting the nodes and defining technological precedence;

developing a Schedule Precedence Graph based on the initial allocation schedule and Technological Precedence Graph additionally including arcs defining nonredundant schedule precedence;

assigning each node in the Schedule Precedence Graph a supply value representing the cost of carrying inventory and delaying delivery;

adding a fictitious node to the Schedule Precedence Graph for each end-product task scheduled for early delivery;

assigning to each arc an initial capacity of zero in the arc direction and an infinite capacity in the direction opposite the arc;

initializing a Facility Queue to contain nodes based on the Schedule Precedence Graph;

selecting and removing the top node from the Facility Queue;

determining whether the selected node has been on a Candidate List;

generating the Candidate List of nodes based on the Schedule Precedence Graph and the selected node;

generating a Move List and a Stay List of nodes based upon the Candidate List;

revising the cumulative delay of the nodes in the Move List;

recording the start times of the nodes in the Stay List; and

reallocating the combination of workers, tasks, and work centers in accordance with the start time of the tasks and performing the tasks in accordance with the reallocation.

11 05195172 Mar 16 1993 395/50 System and method for representing
Jul 2 1990 and solving numeric and symbolic problems

Inventor: Elad; Joseph B. et al.
Assignee: Quantum Development Corporation
Abstract:

A system and method for representing and solving problems which allows a user to enter objects and attributes, and to form a table of at least two dimensions having object-attributes pairs. An object hierarchy is then implemented using the entered objects. The system allows the user to enter constructs to represent relationships among the object-attribute pairs, and also to enter objectives and constraints for the problem. The system allows the user to solve the problem manually or automatically by the system. A score is maintained reflecting how closely the constraints of a problem are to being satisfied and the degree of progress in the direction of the stated objectives of the problem. The system allows representation of hybrid numerical and symbolic problems, and provides solutions to linear or non-linear, discrete or continuous, and feasible or non-feasible constraint satisfaction and optimization problems.

Exemplary Claim [22]:

22. A machine system for representing and solving problems, comprising:

an I/O device for entering information into the machine system in the form of objects, attributes, and constructs including formulas, triggers and rules;

a digital computer for receiving and manipulating said constructs, objects and attributes from said I/O device, said digital computer

comprising:

an electronic memory device for storing said constructs, objects and attributes;

a first module for parsing and translating said constructs entered by said first means into a machine evaluable form;

a second module for automatically defining a tabular representation where said tabular representation contains cells corresponding to object-attribute pairs;

a third module for automatically defining dependencies form said machine evaluable form;

a fourth module for automatically attaching said constructs to object-attribute pairs and for attaching said dependencies of said fourth means;

a fifth module for allowing said object-attribute pairs to inherit said constructs from other object-attribute pairs;

a sixth module for automatically operating on related object-attribute pairs as a function of said defined constructs and dependencies;

a seventh module for automatically utilizing weak and strong problem solving methods in conjunction with said dependencies and chosen values of said object-attribute pairs to find at least a best balanced solution to the problem; and

an eighth module for using heuristics for dynamically interleaving said weak and strong methods.

12 05428712 Jun 27 1995 395/51 System and method for representing
Nov 23 1992 and solving numeric and symbolic problems

Inventor: Elad; Joseph B. et al.

Assignee: Quantum Development Corporation

Abstract:

A system and method for representing and solving problems allows a user to enter objects and attributes, and to form a table of at least two dimensions having object-attribute pairs. An object hierarchy is then implemented using the entered objects. A score is maintained reflecting how closely the constraints of a particular problem are to being satisfied and the degree of progress in the direction of stated objectives of the problem.

Exemplary Claim [30]:

30. A device for representing and solving problems in the form of objects, attributes and constructs, comprising:

a computer-readable medium for use with a digital computer;

a first module for parsing and translating said constructs into a machine evaluable form;

a second module for automatically defining a tabular representation where said tabular representation contains cells corresponding to object-attribute pairs;

a third module for automatically defining dependencies from said machine evaluable form;

a fourth module for automatically attaching said constructs to object-attribute pairs and for attaching said dependencies;

a fifth module for allowing said object-attribute pairs to inherit said constructs from other object-attribute pairs;

a sixth module for automatically operating on related object-attribute pairs as a function of said defined constructs and dependencies;

a seventh module for automatically utilizing weak and strong problem solving methods in conjunction with said dependencies and chosen values of said object-attribute pairs to find at least a best balanced solution to the problem; and

an eighth module for using heuristics for dynamically alternating between said weak and strong methods;

said computer-readable medium for storing computer program logic representative of said objects, attributes and constructs and of said modules.

13 05440480 Aug 8 1995 364/401 R Method for determining flexible
Jun 16 1994 demand in a manufacturing process

Inventor: Costanza; John R.

Assignee: JIT Institute of Technology, Inc.

Abstract:

A system that determines the total demand for a product for each day over four time periods specified by the user of the system. Within the first time period, from the current date up to a demand fence, the total demand cannot be altered. For the next three periods, called the flex fence periods, the total demand for each day can vary by a percentage amount set by the user. If an order exceeding capacity is received for a date beyond the demand fence, the system will recalculate total demand for all days beyond the demand fence and prior to the order date to attempt to produce the total demand quantity necessary to fulfill the order. In calculating the increased quantities, the system uses a formula that prevents the total demand quantity for any day from exceeding the amount of material that was ordered for that day.

Exemplary Claim [1]:

1. In a computerized manufacturing system, a computer implemented method for determining a production quantity for a plurality of flex periods, and ordering material for said production quantity during said plurality of flex periods, said method comprising:

(a) accepting a quantity of flex periods from a user of the system and assigning each flex period a sequential number, wherein said flex periods occur after a demand fence date;

(b) accepting a daily rate total demand from the user of the system, wherein said daily rate total demand equals said production quantity at said demand fence date;

(c) accepting a flex period percentage for each of said flex periods from the user;

(d) accepting a flex period number of days, one said flex period number of days for each said flex periods;

(e) calculating a flex period total demand for each of said flex periods, comprising the steps of

(e1) calculating a first multiplier by dividing said flex period percentage for said flex period by one-hundred and adding one to a result of said dividing to produce said first multiplier,

(e2) calculating a second multiplier by raising said first multiplier to the power of said sequential number assigned to said flex period in step (a), and

(e3) calculating said flex period total demand for said flex period by multiplying said second multiplier by said daily rate total demand, and

(e4) assigning said flex period total demand to each day of said flex period;

(f) accepting at least one customer order from a user of said system;

(g) for each said customer order accepted, increasing said production quantity for all days in each of said flex periods prior to a day of said customer order and after said flex fence date, wherein said production quantity for each of said days does not exceed said flex period total demand set for said day; and

(h) placing an order for material for said production quantity for each of said flex fence periods.

14 05216612 Jun 1 1993 364/468 Intelligent computer integrated
Jul 16 1990 maintenance system and method

Inventor: Cornett; Rickey R. et al.

Assignee: R. J. Reynolds Tobacco Company

Abstract:

An intelligent computer integrated maintenance system and method includes an electronically stored parts manual which contains a hierarchical listing of all parts in production machines, and a maintenance operations computer controller which includes a maintenance schedule management subsystem, an engineering change control subsystem, a parts manual management subsystem and a spares inventory management subsystem. The maintenance schedule management subsystem obtains a schedule of actual and planned production, and groups maintenance activities in order to minimize lost production time. The engineering change control subsystem integrates engineering change activities with maintenance activities to maximize production time. The automated parts manual is also updated to account for engineering changes. The spare parts inventory management subsystem orders spare parts based on predicted maintenance rather than on prescribed inventory levels. Production efficiency is thereby maximized, as is the use of available maintenance manpower. Engineering changes are easily accommodated and spare parts inventory is kept to a minimum.

Exemplary Claim [1]:

1. A computer integrated maintenance system for use with a computer integrated manufacturing system, the computer integrated manufacturing system including a computer controller for controlling a plurality of production complexes each of which includes a plurality of production machines, the manufacturing system computer controller including an electronically stored master schedule file having therein a schedule of actual production and planned production for the plurality of complexes, the manufacturing system computer controller controlling the plurality of production machines based upon the planned production in the master schedule file; said computer integrated maintenance system comprising:

an electronically stored parts manual, containing a hierarchical listing of parts in the plurality of production machines in the plurality of production complexes; and,

maintenance operations computer controlling means, communicatively connected to said electronically stored parts manual and adapted to be communicatively connected to the master schedule file, comprising:

first means for obtaining a schedule of actual production and planned production for the plurality of complexes from the master schedule file;

second means for identifying parts in the hierarchical listing to be maintained during a predetermined time period, and a corresponding maintenance time during the predetermined time period for each identified part, based upon the obtained schedule;

third means for reassigning the corresponding maintenance times for the identified parts, based upon the hierarchical listing of parts in the electronically stored parts manual, to reduce lost production time for each of the plurality of complexes;

fourth means for generating a revised schedule of planned production based upon the reassigned maintenance times for the identified parts; and

fifth means for communicating the revised schedule of planned production to the master schedule file;

whereby the plurality of complexes are controlled based upon the revised schedule of planned production to allow for maintenance activities while maximizing production.

15 05343388 Aug 30 1994 364/402 Method and apparatus for optimally
Oct 29 1993 allocating resources

Inventor: Wedelin; Dag

Abstract:

A method and apparatus for optimizing resource allocation is disclosed which uses a probabilistic relaxation network technique for obtaining an optimal or near optimal assignment solution. A network of nodes and arcs is created. Inputs to the arcs are calculated disregarding the old outputs from the arcs, the influences on the nodes are calculated based on the inputs to the arcs and the new values for the nodes are calculated based on the influences on the node.

Exemplary Claim [1]:

1. A method of outputting the assignment of available personnel to the plurality of tasks so as to effectively accomplish the tasks, using an apparatus for outputting an optimized assignment of available personnel to a plurality of tasks so as to reduce the cost of accomplishing the tasks using a programmed computer, the apparatus comprising preprocessor means for inputting a plurality of legality constraints and outputting a plurality of capacity constraints and variables which are influenced by the capacity constraints, the preprocessor means including a node generator for generating a plurality of nodes representing each possible assignment, a translator for translating a plurality of legality constraints into compatable q-functions, and an arc generator for generating a plurality of arcs forming constraints on the assignments, wherein the variables represent the nodes and the constraints represent the arcs, the method comprising the steps of:

determining the plurality of tasks to be filled by the available personnel;

assigning costs for each of said tasks;

outputting the plurality of variables and influences on said variables in the form of the capacity constraints, from said plurality of tasks and costs using said preprocessor means;

iteratively updating the influences on said variables using a probabilistic relaxation network technique so as to minimize the total of

the costs of said tasks;

terminating said iterative updating steps when the influences remain stable for a predetermined number of iterations;

assigning said personnel to said tasks in accordance with the updated influences; and

outputting the assignment of personnel to said tasks.

16 05319781 Jun 7 1994 395/650 Generation of schedules using a
May 3 1991 genetic procedure

Inventor: Syswerda; Gilbert P.

Assignee: Bolt Beranek and Newman Inc.

Abstract:

In the scheduling method disclosed herein, a genetic algorithm is employed to improve a population of possible schedules represented by respective chromosomes, where the chromosomes upon which the genetic algorithm operates are not a direct encoding of a possible schedules. Rather, the details of the scheduling problem and the real life constraints typically associated with such problems are hidden from the genetic algorithm by the use of a deterministic schedule builder which operates on lists of the desired tasks and which generates legal schedules, i.e. schedules which do not violate hard constraints. The legal schedules so generated are evaluated or scored and the scores are provided to the genetic algorithm as feedback for influencing subsequent operation of the genetic algorithm.

Exemplary Claim [1]:

1. A computer implemented method of scheduling tasks each of which has associated hard and soft constraints, said method comprising:

generating an initial population of sequential task lists;

sequentially fitting the tasks in each list in the then existing population in order into a respective possible schedule observing associated hard constraints thereby to deterministically generate a set of schedules;

evaluating each possible schedule so generated as a function of the associated soft constraints to obtain a ranking of the respective lists;

repetitively applying to the then existing population a genetic algorithm which effects recombination and mutation to members of the population stochastically chosen on the basis of the ranking of the corresponding schedules, thereby to modify the population; and

outputting the schedules generated by the last population, together with their rankings.

17 05548518 Aug 20 1996 364/468.06 Allocation method for generating a
May 31 1994 production schedule

Inventor: Dietrich; Brenda L. et al.

Assignee: International Business Machines Corporation

Abstract:

A novel allocation method for generating a feasible production schedule. The method, in response to a specified requirement q, comprises the steps of determining what quantity (r) of a product can be produced with a specified quantity of supply components; allocating a required quantity of supply components for filling a thus defined partial order; and filling a remainder of the requirement (q-r) at some later time.

Exemplary Claim [1]:

1. An allocation method for utilization within a computer for generating a feasible production schedule in response to a specified requirement q, the method comprising the computer implemented steps of:

(1) determining what quantity (r) of a product can be produced with a specified quantity of supply components;

(2) allocating a required quantity of supply components for filling a thus defined partial order; and

(3) filling a remainder of the requirement (q-r) at some later time;

wherein the steps (1) and (2) and (3) are quantitatively determined by simultaneously solving within the computer a material balance constraint (MBC) inequality and a capacity availability constraint (CAC) inequality, wherein

(i) the MBC comprises a step of comparing

a) a quantity of product for external requirement (over an arbitrary time period) plus a total usage of parts in a production of other parts (over the same arbitrary time period), with

b) a total external availability of parts (over the arbitrary period) plus a total production of parts lover the arbitrary period); and

(ii) the CAC comprises a step of comparing

a) a total quantity of resource (used in the arbitrary time period) with

b) an availability of resource (in the arbitrary time period);

so that if there is not sufficient capacity or material available to meet every requirement, the solution allocates available resources in favor of requirements with high priority.

18 05053970 Oct 1 1991 364/468 Work scheduling method
Sep 15 1988

Inventor: Kurihara; Kenzo et al.

Assignee: Hitachi, Ltd. et al.

Abstract:

In a scheduling system, constraints changing based on situations and scheduling know-how are implemented according to the knowledge engineering method, whereas computations for the concrete, optimal allocation are conducted according to the mathematical programming method. As a result, there can be achieved a scheduling which can easily cope with changes in the scheduling know-how and constraints and which has a high maintainability and a high computation speed.

Exemplary Claim [1]:

1. A scheduling method for making a work schedule for allocating a plurality of work to a plurality of resources in a system including a CPU and a first and second memory means, comprising the steps of:

first representing scheduling constraints and scheduling know-how in a form of knowledge representation by knowledge engineering to make said work schedule and storing said knowledge representation in said first memory means,

second representing a part of optimal allocation in a plurality of programs built-in by mathematical programming and storing said plurality of programs in said second memory means,

determining at least one program from said plurality of programs by use of said knowledge representation stored in said first memory means,

and

repeating said determining step to obtain said work schedule.

19 05392430 Feb 21 1995 395/650 Hierarchical scheduling method for
Oct 30 1992 processing tasks having precedence
constraints on a parallel
processing system

Inventor: Chen; Ming-Syan et al.

Assignee: International Business Machines

Abstract:

A plurality of queries (jobs) which consist of sets of tasks with precedence constraints between them are optimally scheduled in two stages of scheduling for processing on a parallel processing system. In a first stage of scheduling, multiple optimum schedules are created for each job, one optimum schedule for each possible number of processors which might be used to execute each job, and an estimated job execution time is determined for each of the optimum schedules created for each job, thereby producing a set of estimated job execution times for each job which are a function of the number of processors used for the job execution. Precedence constraints between tasks in each job are respected in creating all of these optimum schedules. Any known optimum scheduling method for parallel processing tasks that have precedence constraints among tasks may be used but a novel preferred method is also disclosed. The second stage of scheduling utilizes the estimated job execution times determined in the first stage of scheduling to create an overall optimum schedule for the jobs. The second stage of scheduling does not involve precedence constraints because the precedence constraints are between tasks within the same job and not between tasks in separate jobs, so jobs may be scheduled without observing any precedence constraints. Any known optimum scheduling method for the parallel processing of jobs that have no precedence constraints may be used, but a novel preferred method is also disclosed.

Exemplary Claim [1]:

1. A method of scheduling a multiplicity of tasks having precedence, constraints on a plurality of processors operating in parallel, comprising the steps of:

(a) defining a plurality of jobs, each of said jobs comprising a portion of said tasks and precedence constraints relating pairs of said tasks which are included only within a single job;

(b) for each said job, creating a plurality, of task schedules for said tasks of said job, each of said task schedules corresponding to a different number of said processors which might possibly be allotted to said job and respecting any precedence constraints among said tasks of said job;

(c) determining an estimated job execution time for each of said task schedules;

(d) using said estimated job execution times for each of said jobs and for each different number of processors which might be allocated to each of said jobs, determining an allotment of processors for each of said jobs;

(e) creating a job schedule for said jobs using said determined allotments; and

(f) executing said jobs on said processors using a job schedule created in step (e).

20 05229948 Jul 20 1993 364/468 Method of optimizing a serial
Nov 3 1990 manufacturing system

Inventor: Wei; Kuang C. et al.
Assignee: Ford Motor Company
Abstract:

A method of optimizing a multi-stage serial manufacturing system which includes: (a) providing a quantitative state-space model of said serial manufacturing system that describes processing in terms of sensitivity information and performance in terms of part production and storage/retrieval, said description using process switches in the form of buffer status indicators that express coupling between stages; (b) sensing new sensitivity information that results from simulating said manufacturing system with said model using estimated system performance information; and (c) adjusting said performance information by iteratively using said new sensitivity information in an optimization algorithm, said adjustment being carried out simultaneously with the simulation of step (b).

Exemplary Claim [1]:

1. A method of optimizing a multi-stage serial manufacturing system, comprising:

(a) providing a quantitative state-space model of said serial manufacturing system that describes processing in terms of stages, sensitivity information for blocking or starving of such stages, and performance information in terms of part production and buffer storage/retrieval, said description using process switches in the form of buffer status indicators that express coupling between stages;

(b) using estimated performance information, including buffer size, to simulate said manufacturing system with said model and sensing new sensitivity information that results therefrom; and

(c) concurrently adjusting said performance information, including buffer size, by iteratively using said new sensitivity information in an optimization algorithm to estimate a gradient of the performance information with respect to buffer size and thence adjust buffer size, and repeating steps (b) and (c) until the gradient substantially stabilizes.

21 05128860 Jul 7 1992 364/401 R Manufacturing or service system
Apr 25 1989 allocating resources to associated demands by comparing time ordered arrays of data

Inventor: Chapman; William
Assignee: Motorola, Inc.
Abstract:

An improved method and system is described for allocating manufacturing or process resources having multiple constraints thereon to meet various time varying manufacturing or service demands having multiple parameter requirements.

The demand requirements are expressed as a multi-dimensional time ordered array of vertices Dqt,r,j, for each demand q, wherein t is time and r identifies the physical requirements associated with the qth demand

and j is an integer index running from 1 to J wherein J is the total number of times wherein r has differing values. The available resources are expressed as a multi-dimensional time ordered array of resource vertices Rpt,c,i for each resource p, where c expresses the physical capacities associted with the pth resource, t is time and i is an integer index running from 1 to I where I is the total number of times wherein c has differing values.

A logical system is provided for comparing Rp and Dq to determine when and how Dq may be accommodated by Rp. The invented arrangement provides very compact representation of the demand and resource information so that very complex processes and products may be modeled and scheduled with great time precision without requiring large amounts of memory. The invented arrangement can provide scheduling accuracy of one second over a scheduling interval of a century even with a modest size computer.

Exemplary Claim [1]:

1. A process for altering the physical state of predetermined input materials by allocating one or more resources to meet one or more predetermined demands on the resources, comprising:

providing predetermined input materials having a physical state it is desired to alter;

identifying a plurality of demands for altering the physical state of the predetermined input materials;

providing a plurality of physical resources needed to perform the desired alteration of the physical state of the predetermined input materials;

converting the demands into an array of physical resource capacity requirements for each resource which is ordered in time and has entries only for time values when the required capacities change;

providing for each resource an array of available capacities which is ordered in time and has entries only for time values when the available capacities change;

comparing the time ordered arrays of required and available capacities to determine whether and when the available capacities equal or exceed the required capacities and, when successful, modifying the time ordered array of available capacities to provide an up-dated time ordered array of available capacities reflecting the assignment of available capacities to meet the requirements associated with the demands, wherein the up-dated time ordered array of available capacities only has entries when the up-dated available capacities change; and

applying the resource required first in time to the input materials to change the physical state thereof.

22 05406476 Apr 11 1995 364/402 Method and apparatus for resource
Sep 23 1993 constraint scheduling

Inventor: Deziel, Jr.; Louis B. et al.

Assignee: Sun Microsystems, Inc.

Abstract:

Constrained resource allocation techniques are implemented with a digital computer due to its improved speed and graphics capability. These techniques allow for rapid resource constrained scheduling when given a precedence ordered list of activities. Resources are allocated to activities in order of highest priority with all precedence constraints

being taken into account. Resources are allocated in such a manner that preserves the integrity of the random variables associated with start and finish times of activities. Activity durations and start/finish expected values and variances are adjusted to account for shortfalls occurring prior to an activity's start time and between an activity's start and finish times. The result is a schedule of start and finish times for each activity that is resource feasible and achievable within a prescribed confidence level.

Exemplary Claim [9]:

9. A computer system for resource constrained scheduling of activities in a project network, said computer system comprising a central processing unit, a display monitor comprising a matrix of pixels and a memory, said activities being scheduled in order of precedence, each activity requiring zero or more resources to perform the activity, said computer system comprising:

input means for receiving a list of defined activities, the resources required by each activity and any predecessor activities which must be performed before the activity can be performed, said list of defined activities and said resources being stored in said memory for manipulation by electrical signals under the control at said central processing unit;

means for defining an Unschedulable list in said memory comprising those activities having predecessor activities not yet scheduled;

means for defining a Schedulable list in said memory comprising those activities with scheduled predecessor activities;

means for defining a Scheduled list in said memory for those activities which are scheduled:

means for iteratively scheduling activities comprising;

means for manipulating activities in said memory among the unschedulable, schedulable and scheduled lists, whereby

a current activity is moved from the Unschedulable to the Schedulable list when the current activity has no predecessor activities or the current activity has predecessor activities which have been scheduled;

the current activity is moved from the Schedulable list to the Scheduled list in an order according to a selection mechanism, said current activity is moved once it is determined that the resources required by the current activity are available and the current activity is resource constrained;

if the resources required by the current activity are not available, means for adding a resource arc from the current activity to the scheduled activity which must complete utilization of the resource before the resource is available for the selected activity to use;

calculating means for determining the start time of each activity scheduled preserving the confidence factor of the project network and based upon the incoming activities as identified by the resource and precedence arcs;

means for calculating the finish time of each activity based on the parameters of a probability distribution on activity durations; and

means for generating an electrical signal to actuate the pixels on said display monitor for displaying the schedule of activities,

whereby the uncertainty of activity durations is taken into account and the schedule is resource constrained and feasible.

23 05528516 Jun 18 1996 364/551.01 Apparatus and method for event
May 25 1994 correlation and problem reporting
Inventor: Yemini; Yechiam et al.
Assignee: System Management Arts, Inc.
Abstract:

An apparatus and method is provided for efficiently determining the source of problems in a complex system based on observable events. The problem identification process is split into two separate activities of (1) generating efficient codes for problem identification and (2) decoding the problems at runtime. Various embodiments of the invention contemplate creating a causality matrix which relates observable symptoms to likely problems in the system, reducing the causality matrix into a minimal codebook by eliminating redundant or unnecessary information, monitoring the observable symptoms, and decoding problems by comparing the observable symptoms against the minimal codebook using various best-fit approaches. The minimal codebook also identifies those observable symptoms for which the greatest benefit will be gained if they were monitored as compared to others. By defining a distance measure between symptoms and codes in the codebook, the invention can tolerate a loss of symptoms or spurious symptoms without failure. Changing the radius of the codebook allows the ambiguity of problem identification to be adjusted easily. The invention also allows probabilistic and temporal correlations to be monitored.

Exemplary Claim [1]:

1. A method for detecting problems in a system which generates a plurality of symptoms, the method comprising the steps of:

(1) providing a computer-accessible codebook comprising a matrix of values each corresponding to a mapping between one of said plurality of symptoms and one of a plurality of likely problems in said system;

(2) monitoring a plurality of symptom data values representing said plurality of symptoms generated by said system over time;

(3) determining a mismatch measure between each of a plurality of groups of said values in said codebook and said plurality of symptom data values through the use of a computer, and selecting one of said plurality of likely problems corresponding to one of said plurality of groups having the smallest mismatch measure; and

(4) generating a report comprising said one selected likely problem from said codebook.

24 05148370 Sep 15 1992 364/468 Expert system and method for batch
Jun 26 1991 production scheduling and planning
Inventor: Litt; Maria et al.
Assignee: The Standard Oil Company
Abstract:

A method employed by an expert system for batch scheduling the multiple-pass manufacture of a plurality of parts (12) by at least one parts process (22), where the parts (12) have a plurality of delivery dates and the parts (12) and parts processor (22) have a plurality of production constraints variable during manufacture, includes creating a knowledge base of select characteristics of the parts processor and parameters of the parts, and generating a plurality of rules expressing a scheduling and planning strategy that substantially satisfies parts delivery dates, substantially maximizes use of the parts processor,

substantially maximizes part throughput, substantially minimizes energy utilization of the parts processor and meets the production constraints. Parts (12) suitable for simultaneous processing by the parts processor are combined into all possible preferred combinations by applying a first plurality of the rules to the knowledge base. Preferred combinations are scheduled for manufacture in batches by applying a second plurality of the rules to the knowledge base.

Exemplary Claim [1]:

1. A method for batch scheduling and manufacturing of a plurality of parts by at least one parts processor, the parts having a plurality of delivery dates and the parts and parts processor having a plurality of production constraints variable during manufacture, comprising:

creating a knowledge base of select characteristics of the parts processor and parameters of the parts;

generating a plurality of rules expressing a scheduling and planning strategy that substantially satisfies parts delivery dates and meets the production constraints;

preparing parts for manufacture by the parts processor;

combining parts suitable for simultaneous processing by the parts processor into all possible preferred combinations by applying a first plurality of said rules to said knowledge base;

scheduling said preferred combinations for manufacture in batches by applying a second plurality of said rules to said knowledge base;

collecting a plurality of said prepared parts in a first batch and loading said first batch in the parts processor;

operating said parts processor to at least partially manufacture said first batch and thereafter inspecting said first batch for acceptable manufacture; and,

manufacturing the remaining said preferred combinations in said scheduled batches, including the steps of repeating said step of combining parts suitable for simultaneous processing and said step of scheduling said preferred combinations where said manufacture of parts is unacceptable.

25 04796194 Jan 3 1989 364/468 Real world modeling and control
Aug 20 1986 process

Inventor: Atherton; Robert W.

Abstract:

A modeling and control process for distributed factories having fabrication sequences starts with a definition of how the factory actually operates, rather than a mathematical theory which ultimately leads to a definition of the plant operation. The process begins by delineating a set of factory operating rules which define how part lots interact with machines in actual operation of the factory. A dynamic model of the factory is selected from a group of specimen models for such factories. The model defines the factory by its machines, products, fabrication sequences, collections of job sets, scheduling rules, and machine reliability parameters. The parameters that describe the specific factory are determined and defined in terms of data structures of the individual factory model. The factory specific model contains descriptions of the dynamic interactions of lots and machines. The behavior of the factory can be simulated in detail. A comparision of such a simulation against actual

observation of the factory can be used to refine the model. Because the process begins with a definition of how the factory actually operates, calculations for even very complex-factory simulations, such as integrated circuit fabrication facilities, are simplified so that small computers, such as personal computers, may be employed. The models and simulations can be made accurate enough to allow automatic computer control of the factory using the models and simulations.

Exemplary Claim [1]:

1. A process for modeling a manufacturing plant, which comprises delineating a set of factory operating rules which define how part lots interact with machines in actual operation of the plant, defining the manufacturing plant by specifying machines in the plant and at least batch size and processing time parameters of each machine, defining products manufactured in the plant, providing fabrication sequences consisting of process steps for the products manufactured in the plant, assigning the process steps to the machines, defining at least time and yield characteristics of each process step, identifying which phenomena in the manufacturing plant are stochastic in nature, and assigning distributions and parameters of the distributions to the stochastic phenomena.

26 05467268 Nov 14 1995 364/401 R Method for resource assignment and
Feb 25 1994 scheduling

Status: certificate of correction has been issued

Inventor: Sisley; Elizabeth M. et al.

Assignee: Minnesota Mining and Manufacturing Company

Abstract:

A system and method for assigning and scheduling resource requests to resource providers use a modified "best-first" search technique that combines optimization, artificial intelligence, and constraint-processing to arrive at near-optimal assignment and scheduling solutions. In response to changes in a dynamic resource environment, potential changes to an existing assignment set are evaluated in a search for a better solution. New calls are assigned and scheduled as they are received, and the assignment set is readjusted as the field service environment changes, resulting in global optimization. Each search operation is in response to either an incremental change to the assignment set such as adding a new resource request, removing a pending resource request, reassigning a pending resource request, or to a request for further evaluation. Thus, the search technique assumes that the existing assignment set is already optimized, and limits the task only to evaluating the effects of the incremental change. In addition, each search operation produces a complete assignment and scheduling solution. Consequently, the search can be terminated to accept the best solution generated so far, making the technique an "anytime" search.

Exemplary Claim [1]:

1. A computer-implemented method for assigning a plurality of resource requests among a plurality of resource providers, said plurality of resource requests including a plurality of pending resource requests assigned among said resource providers according to an existing assignment set, wherein said existing assignment set defines a root node of a search tree, said method comprising the steps of:

(a) expanding said root node by forming one or more next-level nodes,

each of said next-level nodes corresponding to said root node but being further defined by a reassignment of one of said pending resource requests between one of said resource providers and another of said resource providers;

(b) estimating, for each of said next-level nodes, a stress value representing a degree of undesirability of the respective reassignment; and

(c) generating a new assignment set corresponding to one of said next-level nodes having a minimum stress value.

27 04888692 Dec 19 1989 364/402 Real-time scheduling system
Nov 10 1988
Inventor: Gupta; Subhash et al.
Assignee: Texas Instruments Incorporated
Abstract:

A system for scheduling the operation of interrelated machines which perform a process flow. A global definition of the system is made once, and each machine has an individual profile describing its local interaction with the system. Local scheduling decisions for each machine are made based on that machines individual profile and the state of the manufacturing facility at the time a decision is needed. Operation of the individual machines is controlled by the local scheduling decisions made therefor.

Exemplary Claim [1]:

1. A method for controlling operation of a plurality of machines which define a process flow having a plurality of processes, comprising the steps of:

(a) performing a steady state analysis of the process flow to obtain relationships between the processes;

(b) generating a plurality of profiles which represent the results of step (a);

(c) assigning each process to at least one of the machines in a predetermined relationship;

(d) for each process, when a predetermined event occurs, making a scheduling decision based on the current state of the process and the contents of an appropriate profile; and

(e) initiating each scheduled process on an assigned machine in accordance with the decision of step (d).

28 04744027 May 10 1988 364/402 Method and apparatus for optimizing
Aug 22 1986 system operational parameters
Inventor: Bayer; David A. et al.
Assignee: American Telephone and Telegraph Company, AT&T Bell Laboratories
Abstract:

Method and apparatus for optimizing the operational state of a system employing iterative steps that approximately follow a projective scaling trajectory or an affine scaling trajectory, or curve, in computing from its present state, x0 to a next state x1 toward the optimum state. The movement is made in a transformed space where the present (transformed) state of the system is at the center of the space, and the curve approximation is in the form of a power series in the step size. The process thus develops a sequence of tentative states x1, x2, xn . . . . It

halts when a selected suitable stopping criterion is satisfied, and assigns the most recent tentative state as the optimized operating state of the system.

Exemplary Claim [1]:

1. Apparatus for optimizing the operating state of a communications network comprising:

a plurality of sensors for developing signals representative of present operating state of said network, said signals being related to controllable parameters of said network;

first processor, responsive to said sensors, for transforming said signals onto a multi-dimensional space such that said operational state of said communications network is at essentially the center of said multi-dimensional space and said constraints form a polytope in said space;

second processor, responsive to said first processor, for computing a path in said space characterized by a power series of order greater than one, along which values of said signals in said space represent a state of said communications network that is monotonically improving with distance from said center; and

third processor, reponsive to said second processor, for selecting a point on said curve, developing a modified set of signals corresponding to said selected point and controlling said parameters of said communication network in accordance with said modified set of signals.

29 04894773 Jan 16 1990 364/402 Method and apparatus for optimizing
Aug 22 1986 system operational parameters
through projective transformations

Inventor: Lagarias; Jeffrey C.

Assignee: American Telephone and Telegraph Company, AT&T Bell Laboratories

Abstract:

Method and apparatus for optimizing the operational state of a system employing iterative steps that approximately follow a projective scaling trajectory or an affine scaling trajectory, or curve, in computing from its present state, x0 to a next state x1 toward the optimum state. The movement is made in a transformed space where the present (transformed) state of the system is at the center of the space, and the curve approximation is in the form of a power series in the step size. The process thus develops a sequence of tentative states x1, x2, xn . . . . It halts when a selected suitable stopping criterion is satisfied, and assigns the most recent tentative state as the optimized operating state of the system.

Exemplary Claim [1]:

1. Apparatus for adjusting, within respective constraint values, the values of a plurality of controllable operational parameters of a commercial system, to achieve an improved operational state of said system, said optimizing being accomplished when said controllable operational parameters are adjusted within a preselected set of constraints to minimize a set of preselected operational criterion values, comprising:

sensors coupled to said commercial system to be optimized for developing signal representations of said values of said operational parameters;

a first processor portion, responsive to said signal representations of said sensors, to values of said preselected set of constraints and to said preselected set of operational criterion values, for developing a canonical form signal representation of said operational state of said system, such that said minimizing is effected by with side condition Ae = 0,

where x is a vector related to said operational parameters, T is the transpose of a vector related to said set of preselected criterion values, n is the number of said operational parameters, A=(a11, a12, . . . , aij, . . . , amn) is an m by n matrix of coefficients related to said preselected set of constraints, and e is a vector of n components, each of which is equal to 1, eT is the transpose of the vector e; said canonical signal representation forming a multidimensional space, with said operational parameters being the variables of said space, said matrix defining a polytope in said space, and said c vector specifying a direction in said space;

a second processor portion, responsive to said first processor portion, for projecting said operational parameters, said matrix, and said c vector unto a transformed space, and developing a matrix Q=(AAT)-1A, a matrix P=(I-ATQ), and a vector c=PDc, where D=diag(xi), A is a matrix that is the matrix A with an additional row of all 1's appended to it, A is the transpose of the matrix A;

a third processor portion, responsive to said second processor portion, for computing a power series function in said transformed space of order greater than one that approximates a trajectory curve in consonance with said set of operational criterion values; and

a controller, responsive to said third processor portion, for developing control signals, for physically setting said operational parameters of said system at values corresponding to a point along said trajectory curve.

30 04914563 Apr 3 1990 364/148 Method and apparatus for optimizing
Aug 22 1986 system operational parameters
through affine scaling

Inventor: Karmarkar; Narendra K. et al.
Assignee: AT&T Bell Laboratories
Abstract:

Method and apparatus for optimizing the operational state of a system employing iterative steps that approximately follow a projective scaling trajectory or an affine scaling trajectory, or curve, in computing from its present state, x0 to a next state x1 toward the optimum state. The movement is made in a transformed space where the present (transformed) state of the system is at the center of the space, and the curve approximation is in the form of a power series in the step size. The process thus develops a sequence of tentative states x1, x2, xn . . . . It halts when a selected suitable stopping criterion is satisfied, and assigns the most recent tentative state as the optimized operating state of the system.

Exemplary Claim [1]:

1. Apparatus for optimizing the operational state of a system in accordance with a preselected operational criterion by adjusting values of operational parameters describing said state of said system, said

operational parameters being adjustable within a preselected set of constraints, characterized by:

first means, responsive to a "true" activation control signal, for developing a tentative state-of-the-system signal representation based on said values of said operational parameters, and for scaling said tentative state-of-the-system signal representation in accordance with an affine scaling vector field that describes the direction of steepest descent in a transformed space to an optimum state of said system in consonance with said operational criterion;

second means responsive to said first means for developing a trajectory curve of order greater than one that approximates said vector field at said tentative state-of-the-system and for modifying said scaled tentative state-of-the-system signal representation to place said tentative state-of-the-system at a point along said curve to form a new tentative state-of-the-system;

third means responsive to said second means for developing said activation control signal, and setting it to "true" when said new tentative state of the system is not within a preselected stopping region, and setting it to "false" when said tentative state of the system is within said preselected stopping region; and

fourth means, responsive to said third means, for setting said operational parameters of said system in accordance with said tentative state-of-the-system when said activation control signal is "false".

31 05276775 Jan 4 1994 395/55 System and method for building
Oct 13 1992 knowledge-based applications

Inventor: Meng; Alex C.

Assignee: Texas Instruments Inc.

Abstract:

A method and system (10) associates a deductive reasoning system having a forward deductive reasoning portion (13), a backward deductive reasoning portion (15), and a frame template portion (18) with a constraint satisfaction system (12) within a unified framework (11). The unified framework (11) incorporates a truth maintenance system to maintain dependency between premises, rules, and consequences in the deductive reasoning system (13, 15, and 18) and between initial constraints and propagated constraints in constraint satisfaction system (12). The system (10) treats constraints as declarative statements in order to maintain logical dependency under the truth maintenance system of unified framework (11).

Exemplary Claim [1]:

1. A computer implemented method for building knowledge-based applications respecting a plurality of entities and combining a plurality of decision aid systems in a unified framework, comprising the steps of:

establishing a truth maintenance system;

receiving a plurality of declarative relationship statements comprising a statement or relationship among at least two of the entities;

establishing within said truth maintenance system a deductive reasoning system, said deductive reasoning system comprising a certain subset of said declarative relationship statements;

establishing within said truth maintenance system a constraint satisfaction system, said constraint satisfaction system comprising a

certain subset of said declarative relationship statements;

recognizing logical dependencies among said declarative relationship statements within said truth maintenance system; and

maintaining said logical dependencies with respect to said declarative relationship statements.

32 05406477 Apr 11 1995 364/401 R Multiple reasoning and result
Jun 10 1994 reconciliation for enterprise
analysis

Inventor: Harhen; John
Assignee: Digital Equipment Corporation
Abstract:

A computer-based method and apparatus for enterprise analysis, with which a user can generate value projections by applying, in parallel, multiple reasoning methods. The invention presents a method and apparatus for creating a complex, networked model of an enterprise, or system and its environment, that is structured from categorized objects and relationships. Using the model, the present invention is self sufficient in determining which areas of the multiple reasoning methods to appy to the variable projection problem. Applying reasoning methods to a single projection problem generates a set of conflicting intermediate hypotheses that the present invention can resolve to form a single final hypothesis through a reconciliation process that evaluates quality factors associated with the intermediate hypotheses. A problem solution tree tracks the solution process to provide to the user a full explanation of the methods chosen or discarded and data relied upon or disregarded.

Exemplary Claim [16]:

16. A computer-based method to project the future value of a variable that relates to an enterprise, the method comprising the steps of:

creating a model of the enterprise;

storing the model of the enterprise;

providing a set of reasoning methods;

providing a set of reconciliation rules;

accepting as input a query that requests information about the future value of the variable;

applying each reasoning method in the set of reasoning methods, each reasoning method utilizing the model, to generate from each reasoning method an intermediate hypothesis as to the future value of the variable; and

reconciling between each reasoning method to obtain the future value of the variable, by

(i) locating available reconciliation rules from the set of reconciliation rules,

(ii) ordering the available reconciliation rules according to a pre-selected preference scheme, and

(iii) applying the available reconciliation rules in the order determined at step (ii).

33 05351195 Sep 27 1994 364/468 Method for improving manufacturing
Mar 12 1993 processes

Status: certificate of correction has been issued
Inventor: Sherman; Mark A.

Assignee: The George Group
Abstract:
The batch size of materials required for each process within a workstation based on a given shipment schedule, as well as the values of several other workstation variables that are determinative of workstation and factory performance are determined. With this information, the user of the invention may schedule production for the factory or spot and prioritize workstations requiring the most improvement, and determine the character and quantity of improvement.
Exemplary Claim [1]:
1. A method for improving the output capacity level of a factory, the factory having a plurality of workstations performing one or more functions, each function operating on a batch of materials, the method comprising the steps of:
inputting an output capacity level for the factory and a selected parameter for improvement;
determining whether the maximum possible variation of the selected parameter would achieve the output capacity level;
determining an achievable capacity output level when the maximum possible improvement of the parameter does not allow for the desired improved output capacity level;
determining the amount of improvement required to achieve the output capacity level when the maximum possible improvement meets or exceeds the output capacity level; and
adjusting the processes of one or more workstations of the factory to implement the parameter improvements.

34 05067148 Nov 19 1991 379/111 Method and apparatus for planning
Dec 14 1990 telephone facilities networks
Status: certificate of correction has been issued
Inventor: Sardana; Sanjeev
Assignee: Nynex Corporation
Abstract:
An acceptable or desired plan for changing the links of a telephone network is developed by using knowledge based rules to generate an ideal plan which meets first constraints, such as demand and modernization constraints, and by modifying the ideal plan to meet one or more second constraints, such as overall cost, while deviating minimally from the ideal plan.
Exemplary Claim [1]:
1. A method for developing an acceptable plan for changing the links serving the nodes of a telephone network comprising the steps of:
developing an ideal plan for changing the links using knowledge based rules adapted to satisfy one or more first constraints;
assessing whether the ideal plan satisfies one or more second constraints and if so identifying the ideal plan as the acceptable plan;
and if the ideal plan fails to satisfy said one or more second constraints, modifying the ideal plan to satisfy at least one of said first constraints and one or more of said second constraints to realize said acceptable plan.

35 05155679 Oct 13 1992 364/402 Set-up optimization for flexible

Dec 18 1989 manufacturing systems

Inventor: Jain; Shailendra E. et al.

Assignee: Hewlett-Packard Company

Abstract:

An iterative method of sequencing jobs in a flexible manufacturing environment where such manufacturing jobs have sequence-dependent set-up times provides for solutions which approximate optimal sequencing while requiring only modest computational resources. Initially, the invention recasts a sequence of manufacturing jobs as a dynamic traveling salesman problem (TSP), in which the system must reconfigure itself and then execute each job in the same way a salesman must visit a sequence of cities, but where the distances between cities change depending upon cities already visited. The first step of the invention reduces the difficult dynamic traveling salesman problem to a static TSP, where distances between each possible job pair are fixed as a monotonic function of parts the two jobs share in common. The second step solves the resulting static traveling salesman problem, by maximizing total distance found by exploiting part commonality between jobs, to obtain a good initial solution to the job sequencing problem. The invention further improves upon the initial solution by selectively perturbing the initial sequence and calculating any changes in the number of part swaps required to reconfigure the manufacturing system. The perturbation and calculations iterate until no improvement is found. The ending sequence should be close to optimal for the job sequence and system. As a final step, a modified "keep part needed soonest" algorithm, accounting for later sequence and overall historical use of parts, optimizes the number of configuration changes for the final sequence. To assure near-optimality for the final sequence, a lower bound calculation provides a limit on how few part changes are possible for the current collection of jobs. The inventive method readily handles job sequencing problems which are difficult or impossible to solve with conventional techniques.

Exemplary Claim [1]:

1. A method of controlling the operation of a machine that is capable of performing a plurality of jobs, each job requiring a plurality of parts, the method comprising:

arranging a plurality of jobs in a first sequence;

calculating a first sequence value by assigning a pair value to each pair of jobs in the first sequence, the pair value being a monotonic function of how many parts are common to both jobs of the pair, and summing the pair values of all the pairs of jobs in the first sequence;

if the monotonic function is positive, finding a maximal job sequence by repeating the arranging and calculating steps for each of a plurality of different possible job sequences and selecting that sequence which has the largest sequence value;

if the monotonic function is negative, finding a maximal job sequence by repeating the arranging and calculating steps for each of a plurality of different possible job sequences and selecting that sequence which has the smallest sequence value;

providing the parts required by the various jobs to the machine in the order of the maximal job sequence; and

causing the machine to perform the jobs with the provided parts in the order of the maximal job sequence.

36 04965742 Oct 23 1990 364/191 Process control system with on-line
Sep 30 1987 reconfigurable modules
Inventor: Skeirik; Richard D.
Assignee: E. I. Du Pont de Nemours and Company
Abstract:

An integrated system for process control in which a process supervisor procedure (which is preferably the top-level procedure) is configured as a modular software structure with modules which can be revised by a user at any time, without significantly interrupting the operation of the process supervisor. Users can define or redefine modules by editing highly constrained templates. These templates use a standardized data interface (as seen by the user), which facilitates communications with an extremely wide variety of systems. The template set preferably contains highly constrained portions (which are optimized for the most common functions), and also contains pointers to user-customized functions. Thus, rapid set-up and modification are possible, but sophisticated users still have full flexibility to do customization.

Exemplary Claim [1]:

1. A computer-based method for operating a substantially continuous process, comprising the steps of:

(1) operating the process with one or more sensors connected to sense conditions in materials being processed, and one or more actuators connected to change conditions in the process;

(2) controlling one or more of said actuators with a process controller in accordance with signals received from said sensors and in accordance with one or more control parameters;

(3) running a process supervisor procedure comprising one or more software modules, for selectively defining one or more of said control parameters for said process controller;

(4) selectively presenting a functional structure to a user, for a new software module for said process supervisor procedure and/or a functional structure corresponding to the user input from which a current software module of said process supervisor procedure was generated, and selectively loading the user input from said functional structure to be used by said process supervisor procedure;

wherein step (4) of presenting a functional structure includes presenting standardized data interface definitions further comprising the step (5) of enabling each said software module to perform the steps of

getting data from any one of a plurality of data collection and/or process control systems

and/or sending process control parameters to any one of a plurality of data collection and/or process controls systems

without the user explicitly defining any custom data interfacing procedures.

37 04884217 Nov 28 1989 395/66 Expert system with three classes of
Sep 30 1987 rules
Inventor: Skeirik; Richard D. et al.
Assignee: E. I. Du Pont de Nemours and Company
Abstract:

An expert system wherein the rules are of three classes: (1) retrieval rules, which each associate one of several attributes to an object in

accordance with the values of inputs; (2) analysis rules, which selectively associate an attribute with an object, and which are somewhat analogous to the natural-language inference rules which would be used in communications between domain experts; and (3) action rules, which selectively carry out the output and control actuation options, based on the attributes associated with objects by the other rules.

Preferably only the action rules can enable execution of an external command procedure. Preferably each of each of the action rules requires no logical operations other than a test for association between an attribute and an object. Preferably none of the action rules can associate an attribute with an object. Preferably only the retrieval rules include numeric operations.

Exemplary Claim [1]:

1. An expert system, comprising:

a collection of inference rules, consisting of

retrieval rules, respective ones thereof including standards for associating an attribute with an object selectively in accordance with input values; and

non-retrieval rules, respective ones thereof each performing a function selected from the group consisting of:

associating an attribute with an object selectively in accordance with object/attribute associations made by ones of said rules, and/or;

selectively executing an external command in accordance with attribute/object associations made by ones of said rules;

a processor connected to receive inputs from an input channel, to execute said collection of inference rules on said inputs, and to provide outputs on an output channel accordingly,

wherein said processor is not programmed to perform any purely arithmetic test while executing said non-retrieval rules.

38 04920499 Apr 24 1990 395/12 Expert system with natural-language
Sep 30 1987 rule updating

Inventor: Skeirik; Richard D.

Assignee: E. I. Du Pont de Nemours and Company

Abstract:

An expert system for process control, which permits the inference rules to be revised at any time without requiring the specialized skills of a "knowledge engineer". The inference rules are intitially defined by a domain expert who fills in blank fields in a set of highly constrained substantially natural-language templates. The rule set thus specified is automatically translated to define an operational expert system. Updating can be performed by a domain expert at any time: the set of templates with the data fields as originally entered is redisplayed, so that the domain expert can edit the accessible fields and then command the modified rule set to be automatically translated, to define a modified operational expert system.

Exemplary Claim [1]:

1. An expert system comprising:

a processor connected to receive inputs from a plurality of sources;

a collection of inference rules which are executable by said processor; and

one or more output channels, connected so that said processor provides

outputs on said output channels in accordance with inputs received on said input channels;

wherein said processor is also configured to, on command of a user, present said inference rules in a constrained format which is readily understandable by a user who is not necessarily competent in any computer language, and permit said user to alter said executable rules by modifying said rules within said constrained substantially natural language format.

39 05233533 Aug 3 1993 364/468 Scheduling method and apparatus
Dec 19 1989

Status: certificate of correction has been issued

Inventor: Edstrom; Nils O. et al.

Assignee: Symmetrix, Inc.

Abstract:

Scheduling software provides date and time allocation of resources to a sequence of processes for manufacturing a desired item. Scheduling is performed by a backward-forward method and alternatively by an backward-jump forward method to meet a requested due date. Resources are dynamically allocated to satisfy processes according to pre-established rules for allocation. Also resources are allocated in certain amounts or in a predetermined pattern to minimize waste or left over amounts of the resource. To allocate certain resources, purchase or production of the resource is scheduled first.

Exemplary Claim [1]:

1. A method for scheduling a desired sequence of events which is to be accomplished by a certain date, comprising the steps of:

for a given sequence of events each having a predeterminable length of time to accomplish and requiring predetermined amounts of resources, and for a given due date when all events in the given sequence must be accomplished, selecting one event at a time from the given sequence, in backward sequence order from a last event to a first event in the given sequence;

for each successive selected event, serially scheduling a working length of time for that event, the working length of time being equal to the respective length of time to accomplish the event during a length of time in which the respective resources are available in the predetermined amounts; the serial scheduling of working lengths of time for each successive selected event including serially scheduling the working lengths of time from the given due date backward in time toward but excluding a present date; and

rescheduling the working lengths of time for the sequence of events if the serial scheduling of working lengths of time requires inclusion of the present date.

40 05006992 Apr 9 1991 395/68 Process control system with
Sep 30 1987 reconfigurable expert rules and
control modules

Inventor: Skeirik; Richard D.

Assignee: Du Pont de Nemours and Company

Abstract:

An integrated system for process control in which a process supervisor procedure (which is preferably the top-level procedure) is configured as a

modular software structure, with modules which can be revised by a user at any time, without significantly interrupting the operation of the process supervisor. The modular software structure can define control parameters for many process control procedures, and can retrieve data from many sources (preferably including a historical database of process data, which can provide time-stamped data). The supervisor can also call on various expert subprocedures. Preferably the expert subprocedures can also be modified by an authorized user at any time, by calling up and editing a set of natural-language rule templates which correspond to the rules being executed by the expert subprocedure.

Exemplary Claim [1]:

1. A computer-based method for operating a substantially continuous process, comprising the steps of:

(1) operating the process with one or more sensors connected to sense conditions in the process, and one or more actuators connected to change conditions in the process;

(2) controlling one or more of said actuators with a process controller in accordance with signals received directly from one or more of said sensors and in accordance with one or more control parameters; and

(3) running a process supervisor procedure, comprising one or more software modules, for selectively defining one or more of said control parameters for said process controller, said process supervisor procedure also calling on at least one expert subprocedure which uses a knowledge base and inference structure relevant to the process.

41 04907167 Mar 6 1990 364/500 Process control system with action
Sep 30 1987 logging

Inventor: Skeirik; Richard D.

Assignee: E. I. Du Pont de Nemours and Company

Abstract:

An integrated system for process control in which a process supervisor procedure defines parameters for one or more controller systems (or control procedures). The supervisor procedure changes control parameters only in discrete changes, and the decision to act is sufficiently constrained that every change must be a significant change. Every change is logged (or otherwise reported out to human experts). Since every change is significant, the history of changes will provide a meaningful record which can be reviewed by human experts.

Exemplary Claim [14]:

14. A computer-based method for operating a substantially continuous process, comprising the steps of:

(1) operating the process with one or more sensors connected to sense conditions in the process, and one or more actuator connected to change conditions in the process;

(2) controlling one or more of said actuators with a process controller in accordance with signals received from said sensors and in accordance with control parameters; and

(3) repeatedly running a process supervisor procedure for selectively defining one or more of said control parameters for said process controller;

(4) wherein, for each of said control parameters, said process supervisor procedure is constrained not to make changes to said control

parameters unless the amount of the change would exceed a certain threshold.

42 04910691 Mar 20 1990 395/11 Process control system with
Sep 30 1987 multiple module sequence options
Inventor: Skeirik; Richard D.
Assignee: E.I. Du Pont de Nemours & Co.
Abstract:

An integrated system for process control in which a process supervisor procedure (which is preferably the top-level procedure) is configured as a modular software structure, with modules which can be revised by a user at any time without significantly interrupting the operation of the process supervisor. A user can define or redefine modules by editing highly constrained templates, which preferably include module timing and sequencing options including: block becomes active if another specified block has become active; block becomes active if a new value has been entered for a specified data source; block becomes active if a specified time of inactivity has elapsed; and combinations of these.

Exemplary Claim [1]:

1. A computer-based method for operating a substantially continuous process, comprising the steps of:

(1) operating the process with one or more sensors connected to sense conditions in the process, and one or more actuators connected to change conditions in the process;

(2) controlling one or more of said actuators with a process controller is accordance with signals received from said sensors and in accordance with control parameters;

(3) repeatedly running a process supervisor procedure comprising one or more software modules, for selectively defining one or more of said control parameters for said process controller;

(4) presenting a functional structure to a user, for a new software module and said process supervisor procedure and/or a functional structure corresponding to the user input from which a current software module of said process supervisor procedure was generated, and selectively loading user inputs into said functional structure to be used by said process supervisor procedure;

(5) wherein said functional structure permits the user to define timing and sequencing parameters for respective ones of said software modules which include at least the following options:

(a) become active if another specified software module has become active;

(b) become active if a new value has been, entered for a specified data source; or

(c) become active if a specified time of inactivity has elapsed.

43 05260868 Nov 9 1993 364/402 Method for calendaring future
Oct 15 1991 events in real-time
Inventor: Gupta; Subhash et al.
Assignee: Texas Instruments Incorporate
Abstract:

A mechanism and method for calendaring a plurality of events such as scheduling the operation of interrelated machines which perform a process

flow. Future time is divided into segments, called buckets, of increasing length. The first two buckets are of the same size and each of the following buckets twice as large as its preceding bucket. The first bucket slides so as to always cover a specified length of time following the current time. Events scheduled in the calendar is added to the appropriate bucket, depending on how far in the future it is to take place. When the current time equals the scheduled time for an event, then that event is removed from the bucket where it resides. When a bucket has become empty because all events have been removed from it, the events in the following bucket are distributed over the two buckets preceding it.

Exemplary Claim [1]:

1. A method to be performed by a machine for calendaring a plurality of events which are to occur on a plurality of machines at various times to thereby control operation of and improve scheduling of said plurality of machines, comprising the steps of:

(a) dividing future time spans into a plurality of segments of unequal length, wherein later segments are predetermined multiples of the length of the first segment;

(b) placing events to occur on any of the said plurality of machines in appropriate buckets representative of the time segments;

(c) incrementing a clock, wherein each of said events are removed from the first bucket when the clock reaches their calendared time; and

(d) dividing the events contained in larger buckets among appropriate smaller buckets when previous buckets have been emptied, and resetting the time represented by the first bucket to the current time.

44 05287267 Feb 15 1994 364/403 Methods for parts procurement
May 10 1991 quantity determination where demand is uncertain for the product in which the parts are used

Inventor: Jayaraman; Rangarajan et al.

Assignee: International Business Machines Corporation

Abstract:

Methods are described for predicting parts procurement requirements for products over a plurality of time periods, with certain of the parts being common to a plurality of products. The actual demand for the products is unknown, but the method assures that a specified service level is met for all products and minimizes expected excess part inventories. The methods are provided with inputs which, among others, includes lists of parts for each product, prices for the parts, and demand forecasts for each product in each time period, each forecast in the form of a mean and standard deviation. The description of the problem includes an objective function of minimizing expected excess inventory while satisfying the constraint that a specified service level be achieved. The problem is transformed into an unconstrained problem through the use of a Lagrange multiplier. The solution is achieved by performing a one parametric search on the value of the multiplier. The solution may achieve higher service levels than specified. Additional methods are described for improving the procurement decisions to more closely meet the service requirement.

Exemplary Claim [1]:

1. A stochastic method for determining, over a series of time periods, parts procurement requirements for products, certain said parts used in a

plurality of products, wherein actual demand for said products is unknown, said method adapted to meet a specified service level for all products and to minimize expected excess part inventories, the method having inputs comprising, lists of parts for each said product, prices for said parts, and forecasts of demands for each said product in each time period, the method comprising computer implemented steps of:

a. deriving a first cumulative demand D'ci,t for each part ci through a current time period t, and a second cumulative demand Dci,t for each part ci through a time period t-1, added to the demand for each part in current time period t, modified by a specified volume fraction of actual demand for each part in period t that is to be satisfied in period t, each cumulative demand expressed by a mean and standard deviation;

b. determining a minimum cumulative procurement quantity q'*ci,t for each part through time period t that meets said specified service level, from a demand distribution function FDci,t from said second cumulative demand;

c. finding a factor (), for each part, at said determined minimum cumulative procurement quantity, that satisfies equation 6t: 6t

where:

ci is part i,

Pci is the cost of part i,

t is the time period,

q'ci,t is the cumulative procurement of part i up to period t,

FD'ci,t(q'ci,t) is the cumulative distribution function of the random variable q'ci,t,

* means, at optimality,

t is the LaGrange Multiplier for time period t,

Dci,t(q'ci,t) is the density function of the random variable q'ci,t,

FDci,t(q'ci,t) is the cumulative distribution function of the random variable q'ci,t,

i means for all i, i.e., i=1,2, . . .

d. employing a maximum value factor () found in step c to derive for each part, a new cumulative procurement quantity from equation 6t over all time periods through t, and based thereon, an overall service level for each part, said overall service level for each part determined by taking the product of cumulative demand distribution functions for all parts, as determined from said second cumulative demands, evaluated at said new cumulative procurement quantity;

e. finding if said new cumulative procurement quantities for all parts provide a service level equal to said specified service level, and, if not, revising said factor (), and repeating steps d and e employing the revised factor () until said specified service level is achieved; and

f. employing resultant procurement quantities that enable achievement of the service level for acquisition of said parts.

45 05255181 Oct 19 1993 364/401 R Method of planning organizational
Jun 1 1990 activities

Status: certificate of correction has been issued

Inventor: Chapman; William et al.

Assignee: Motorola, Inc.

Abstract:

A method for translating complex process flow networks into plans or

schedules for the manufacturing of products or the performance of other organizational activities is disclosed. The method maintains a time-valued list of existing commitments to resources. Allocations of these resources are made to lots during a simulation procedure which calculates a resulting plan's timing data. The method simulates higher priority lots before it simulates lower priority lots. A simulation evaluates the process flow description to obtain the relative order of consuming and releasing resources, resource attributes and related capabilities, initial minimum timing requests, and process control rules. The simulation uses the list to determine when resources may be used without impacting prior commitments of the resources. In addition, the simulation forces the allocations to conform to the process control rules. The resulting timing data is merged into the processing plan, and resource commitments are then made to the simulated resource. When lower priority lots are simulated, commitments have already been made to higher priority lots. Thus, the lower priority lots cannot receive resource allocations which impact the higher priority lots. However, the lower priority lots may receive allocations which occur prior to contending allocations to higher priority lots.

Exemplary Claim [1]:

1. A method for allocating a multiplicity of organizational resources to a plurality of organizational lots to accomplish organizational goals, said method comprising the steps of:

forming a list which identifies time-valued commitments to future uses of said resources by a first portion of said lots;

identifying one of said lots not included within said first portion of said lots, said one lot having a demand for said resources which is defined by instructions presented in a process flow description associated with said one lot;

obtaining said process flow description;

simulating allocation of said resources to said lot in accordance with said demand and said process flow description instructions, said simulated allocations refraining from interfering with said commitments identified in said list; and

modifying said list to reflect commitments to said one lot.

46 05195041 Mar 16 1993 364/468 Method and apparatus for improving
Jul 24 1989 manufacturing processes

Inventor: George; Michael L. et al.

Assignee: Institute of Business Technology

Abstract:

The invention determines the batch size of materials required for each process within a workstation based on a given shipment schedule, as well as the values of several other workstation variables that are determinative of workstation and factory performance. With this information, the user of the invention may schedule production for the factory or spot and prioritize workstations requiring the most improvement, and determine the character and quantity of improvement.

Exemplary Claim [1]:

1. A method of scheduling and operating production of a factory having a plurality of work stations, each work station performing one or more processes, in order to meet a predetermined shipping schedule, comprising

the steps of:

(a) determining the rate of material flow out (FLOWOUTij) of each process within each workstation of a factory necessary for the factory to meet a predetermined shipping schedule;

(b) determining the size of the batch of material for each process of each workstation necessary to meet each material flow rate determined in step (a) for the workstation; and

(c) operating each process at each workstation with the batch sizes determined in step (b).

47 05077661 Dec 31 1991 364/402 Assignment-dependent resource
May 3 1989 allocation method

Inventor: Jain; Shailendra K. et al.

Assignee: Hewlett-Packard Company

Abstract:

An iterative, assignment-dependent, method of allocating manufacturing resources to perform operations required in the manufacture of multiple products provides for improved conformance with actual manufacturing situations and for solutions which approximate optimal allocation while requiring only modest computational power and time. The first step involves attributing complex costs to potential assignments of operations to resources. Complex costs include two components, combined money-costs and combined times. Combined cost is an assignment dependent variable which can equal operational cost or the sum of operation cost and set-up cost depending on assignments that have already been made. Combined time is likewise assignment dependent. In a second step, combined cost is selected as a parameter to evaluate each potential operation-resource pair. In a third step, a lowest cost and a second lowest cost resource are determined for each unassigned operation. In a fourth step, a maximum penalty operation is identified by finding the maximum difference between lowest and second lowest costs. In a fifth step, the maximum penalty operation is assigned to its lowest cost resource. In a sixth step, combined costs are re-evaluated to take the most recent assignment into account. In a seventh step, iteration is continued by returning to the third step until all operations have been assigned to resources. Once all operations have been assigned, the assignments are reported as a solution to the allocation problem. The inventive method readily handles capacity constrained resource allocation problems, which are difficult or impossible to solve with conventional techniques.

Exemplary Claim [1]:

1. A method of allocating processing resources to maximize complex-cost-effectiveness, wherein plural products, each requiring at least one processing operation, are to be processed on plural processing resources, each of said operations being performable on at least one of said resources, each of said operations belonging at any given time to one of two sets, an assigned set and an unassigned set, said assigned set including all operations which have been assigned to resources, said unassigned set including all operations which have not been assigned to resources, said assigned set including a whole number of elements, said unassigned set including a whole number of elements, said assigned set defining an assignment map the elements of which are operation-resource pairs, each operation-resource pair including an operation and the

resource to which it has been assigned; said method comprising the following series of steps and mathematic equivalents thereof:

1) attributing a complex cost to each potential assignment of an unassigned operation to a resource, said complex cost including a money-cost and time-cost, the complex cost for each operation-resource pair being a function of and varying according to the assignment map existing at the time of the potential assignment;

2) evaluating potential assignments according to a parameter to obtain a respective parameter value, the magnitude of said parameter value negatively correlated to said effectiveness, said parameter being a function of complex cost, said parameter having an associated comparison function which can be used to compare two parameter values so that a comparison value is obtained, the magnitude of said comparison value providing a measure of differences in effectiveness;

3) determining a most effective resource for each of said unassigned operations, said most effective resource being the resource belonging to the potential assignment with the lowest parameter value for a given operation, also identifying a second most effective resource for each of said unassigned operations, said second most effective resource being the resource belonging to the potential assignment with the second lowest parameter value for a given operation;

4) identifying a maximum penalty operation by comparing parameter values of the most effective resource and the second most effective resource for each operation according to said comparison function to obtain a respective comparison value, then selecting the operation associated with the maximum comparison value;

5) assigning said maximum penalty operation to its most effective resource, changing assignment maps by changing the status of said maximum penalty operation from unassigned to assigned;

6) re-evaluating those of said parameter values affected by changes in complex costs due to the immediately preceding change in assignment maps;

7) iterating steps 3-6 until all operations are assigned;

8) allocating resources in correspondence with the assigned operations;

9) moving the products to the respective allocated resources; and

10) performing the assigned operations on the products by means of the respective allocated resources.

48 04965743 Oct 23 1990 395/50 Discrete event simulation tool for
Jul 14 1988 analysis of qualitative models of
continuous processing system

Inventor: Malin; Jane T. et al.

Assignee: The United States of America as represented by the Administrator of the National Aeronautics and Space Administration

Abstract:

An artificial intelligence design and qualitative modelling tool is disclosed for creating computer models and simulating therein continuous activities, functions and/or behavior using developed discrete event techniquers. Conveniently, the tool is organized in four modules: library design module, model construction module, simulation module, and experimentation and analysis. The library design module supports the building of library knowledge including component classes and elements

pertinent to a particular domain of continuous activities, functions and behavior being modelled. The continuous behavior is defined discretely with respect to invocation statements, effect statements and time delays. The functionality of the components is defined in terms of variable cluster instances, independent processes and modes, further defined in terms of mode transition processes and mode dependent processes. Model construction utilizes the hierarchy of libraries and connects them with appropriate relations. The simulation executes a specialized initialization routine and executes events in a manner that includes selective inherency of characteristics through the library hierarchy and runs the events through a time and event schema until the event queue in the simulator is emptied. The experimentation and analysis module supports analysis through the generation of appropriate log files and graphics developments and includes the ability of log file comparisons.

Exemplary Claim [1]:

1. A method for off-line experiments and analyses of an application specific system of components using qualitative modeling and discrete event simulation to analyze dynamic system effects of changes in components with continuous behavior, including malfunction, comprising the steps of:

providing a library knowledge base of domain specific modeling elements which includes components with modes, mode transition, variables, and behavior descriptions, a qualitative algebra for defining and combining component variables, and relations to link the components, constructed relative to the application specific system,

providing a model knowledge base for the application specific system, which includes component instances, each with a current mode, linked by relation instances,

providing change control mechanisms, independent and distinct from the domain specific modeling elements, to select and control effects of changes within the model knowledge base, to control a time-ordered simulation,

inputting data, which may include malfunction data, to effect changes in the component instances within the model knowledge base, either by changing a variable value of a component instance or by changing the current mode of a component instance,

updating variable values and the current mode of component instances, and propagating changes through the model knowledge base in a time-ordered fashion in response to the input data and resulting changes, under control of the change control mechanisms,

and outputting information in response to the changes in variable values and the current mode of component instances and to the propagation of changes through the model knowledge base, to support analysis of effects of changes which may include malfunctions, on modes of component instances, and to support analysis of diagnostic experiments in which effects of malfunctions on the system are compared.

49 04744028 May 10 1988 364/402 Methods and apparatus for efficient
Apr 19 1985 resource allocation

Inventor: Karmarkar; Narendra K.

Assignee: American Telephone and Telegraph Company, AT&T Bell Laboratories

Abstract:

A method and apparatus for optimizing resource allocations is disclosed which proceeds in the interior of the solution space polytope instead of on the surface (as does the simplex method), and instead of exterior to the polytope (as does the ellipsoid method). Each successive approximation of the solution point, and the polytope, are normalized such that the solution point is at the center of the normalized polytope. The objective function is then projected into the normalized space and the next step is taken in the interior of the polytope, in the direction of steepest-descent of the objective function gradient and of such a magnitude as to remain within the interior of the polytope. The process is repeated until the optimum solution is closely approximated. The optimization method is sufficiently fast to be useful in real time control systems requiring more or less continual allocation optimization in a changing environment, and in allocation systems heretofore too large for practical implementation by linear programming methods.

Exemplary Claim [1]:

1. A method for allocating the available telecommunication transmission facilities among the subscribers demanding service at a particular time so as to reduce the total cost of operating said transmission facilities, where the available transmission facilities, the subscribers, and the total cost are related in a linear manner, said method comprising the steps of:

tentatively and iteratively reassigning said available telecommunications transmission facilities to said subscribers so as to reduce said total costs at each said reassignment,

each said reassignment being determined by normalizing the previous assignment with respect to constraints on said allocations,

terminating said iterative reassigning steps when said costs are below a preselected threshold, and

allocating said transmission facilities in accordance with the reduced cost assignment.

50 04744026 May 10 1988 364/402 Methods and apparatus for efficient
Apr 11 1986 resource allocation

Inventor: Vanderbei; Robert J.

Assignee: American Telephone and Telegraph Company, AT&T Bell Laboratories

Abstract:

A method and apparatus for optimizing resource allocations is disclosed which utilizes the Karmarkar algorithm to proceed in the interior of the solution space polytope. At least one allocation variable is assumed to be unconstrained in value. Each successive approximation of the solution point, and the polytope, are normalized such that the solution is at the center of the normalized polytope using a diagonal matrix of the current solution point. The objective function is then projected into the normalized space and the next step is taken in the interior of the polytope, in the direction of steepest-descent of the objective function gradient and of such a magnitude as to remain within the interior of the polytope. The process is repeated until the optimum solution is closely approximated.

The resulting algorithm steps are advantageously applied to the phase of one problem of obtaining a starting point, and to the dual problem, where the free variable assumption produces unexpected computational

advantages.

Exemplary Claim [1]:

1. A method for allocating available industrial facilities among the users of said facilities so as to reduce the total cost of providing said facilities, said method comprising the steps of:

tentatively and iteratively reassigning said available facilities to said users in accordance with the Karmarkar algorithm so as to reduce said total costs at each said reassignment,

each said reassignment being determined by normalizing the previous assignment with respect to constraints on said allocations,

during each said reassignment, adjusting the direction of changes in said previous assignments under the assumption that at least one of said constraints increases in value without limit,

terminating said iterative reassigning steps when said costs are reduced to a preselected threshold to form a final reduced cost assignment, and

allocating said facilities in accordance with the final reduced cost assignment.

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Set	Items	Description
S1	3111490	PRODUCTION? OR FACTORY OR FACTORIES OR MANUFACTUR? OR SHOP? OR ASSEMBLY()LINE? OR ASSEMBLYLINE?
S2	7482	(OPTIMIZ? OR OPTIMIS?)(7N)SCHEDUL?
S3	65336	LINEAR(2W)PROGRAM?
S4	3023	CONSTRAINT?(7N)VIOLAT?
S5	6	S1 AND S2 AND S3 AND S4
S6	6	S5 NOT (PY=>1995 OR CY=>1995 OR PD=>941011)
S7	3	RD (unique items)
S8	12773	(OPTIMIZ? OR OPTIMIS?)(S)SCHEDUL?
S9	4783	CONSTRAINT?(S)VIOLAT?
S10	8	S1 AND S3 AND S8 AND S9
S11	2	S10 NOT S6
S12	2	RD (unique items)
S13	643	S8 AND CONSTRAIN? AND (LOOKAHEAD OR LOOK?()AHEAD OR FORWARD OR BACKWARD OR HEURISTIC? OR ITERAT?)
S14	36	S13 AND VIOLAT?
S15	23	RD (unique items)
S16	16	S15 NOT (PY=>1995 OR CY=>1995 OR PD=>941011)

?t s7/7/all

7/7/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC

4638000 INSPEC Abstract Number: B9405-0260-006, C9405-1290F-031
Title: The single-item discrete lotsizing and scheduling **problem:** optimization **by** linear **and dynamic** programming
Author(s): Van Hoesel, S.; Kuik, R.; Salomon, M.; Van Wassenhove, L.N.
Author Affiliation: Erasmus Univ., Rotterdam, Netherlands
Journal: Discrete Applied Mathematics vol.48, no.3 p.289-303
Publication Date: 15 Feb. 1994 Country of Publication: Netherlands
CODEN: DAMADU ISSN: 0166-218X
U.S. Copyright Clearance Center Code: 0166-218X/94/$07.00
Language: English Document Type: Journal Paper (JP)
Treatment: Practical (P); Theoretical (T)
Abstract: This paper considers the single-item discrete lotsizing and scheduling problem (DLSP). DLSP is the problem of determining a minimal cost **production** schedule, that satisfies demand without backlogging and does not **violate** capacity **constraints** . We formulate DLSP as an integer programming problem and present two solution procedures. The first procedure is based on a reformulation of DLSP as a **linear programming** assignment problem, with additional restrictions to reflect the specific (setup) cost structure. For this **linear programming** (LP) formulation it is shown that, under certain conditions on the objective, the solution is all integer. The second procedure is based on dynamic programming (DP). Under certain conditions on the objective function, the DP algorithm can be made to run very fast by using special properties of optimal solutions. (8 Refs)

7/7/2 (Item 2 from file: 2)
DIALOG(R)File 2:INSPEC

04110563 INSPEC Abstract Number: C9204-1290F-097
Title: A goal programming network for mixed integer linear programming **: a case study for the job-** shop **scheduling problem**
Author(s): Van Hulle, M.M.
Author Affiliation: Lab. voor Neuro-en Psychofysiologie, Katholieke Univ. Leuven, Belgium
Journal: International Journal of Neural Systems vol.2, no.3 p. 201-9
Publication Date: 1991 Country of Publication: Singapore
CODEN: IJSZEG ISSN: 0129-0657
Language: English Document Type: Journal Paper (JP)
Treatment: Theoretical (T)
Abstract: Job- **shop scheduling** is an np-complete **optimization** problem subject to precedence and resource constraints. Foo and Takefuji (1988) introduced a network-based solution procedure for solving job-**shop** problems formulated as mixed integer **linear programming** problems. To obtain the solution, the Tank and Hopfield **linear programming** network was repeatedly used. However, since such a network frequently produces **constraint -violating** solutions, the reliability of Foo and Takefuji's approach is doubtful. It is shown that reliability of the network approach can be greatly improved, by guaranteeing constraint-satisfying solutions, if the original job-**shop** problem is reformulated as a goal programming problem, before it is mapped onto a goal programming network. (11 Refs)

7/7/3 (Item 1 from file: 35)
DIALOG(R)File 35:Dissertation Abstracts Online

1064684 ORDER NO: AAD89-15154
THE WAREHOUSE SCHEDULING PROBLEM
Author: HARIGA, MONCER
Degree: PH.D.
Year: 1988
Corporate Source/Institution: CORNELL UNIVERSITY (0058)
Source: VOLUME 50/03-B OF DISSERTATION ABSTRACTS INTERNATIONAL.
PAGE 1093. 120 PAGES

We discuss the deterministic, infinite horizon, infinite **production** rate, infinite backorder cost, multi-item inventory stocking problem with a restriction on warehouse volume or floor space available. Our main goal is to determine a cyclic ordering pattern that minimizes the long run average ordering and holding costs per unit of time without **violating** the warehouse capacity **constraint** . We refer to the combined problem of order sizing and delivery **scheduling** for **optimizing** this system as the Warehouse **Scheduling** Problem, WSP.

We restrict attention to cyclic schedules that correspond to the delivery times with inventory runouts, the so-called Zero Switch Rule. We show that this rule is satisfied for any optimal cyclic schedule. Under this restriction, we formulate the WSP as a mixed integer nonlinear program. Due to the complexity of such a formulation, we decompose the WSP into different subproblems. For given order frequencies, we develop the Arbitrary Frequencies Bin Packing Heuristic which may be used for arbitrary integer frequencies to generate an order sequence. For a given sequence, we formulate a **linear program** to minimize the maximum storage space used. We show that its optimal solution is characterized by filling the warehouse at each order. We formulate the problem that minimizes the holding cost under the storage space constraint as a quadratic program and give conditions under which it has the same optimal solution as the **linear program** . When the lot sizes for multiple orders of each part are restricted to be equal, we devise an efficient algorithm to compute the optimal maximum space used. Finally, we integrate all the subproblem heuristics into an iterative algorithm to determine a good cyclic schedule. The algorithm compares favorably with all others in the literature in both solution quality and computational effort.
?

?t s12/7/all

12/7/1 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)

03668422 E.I. No: EIP93061007443
Title: Impacts of hydropower operation on water supply from lower Colorado River in Texas
Corporate Source: Lower Colorado River Authority, Austin, TX, USA
Conference Title: Proceedings of the 20th Anniversary Conference on Water Management in the '90s
Conference Location: Seattle, WA, USA Conference Date: 19930501-19930505
Sponsor: ASCE; American Consulting Engineers Council; American Water Resources Assoc; American Water Works Assoc; Bureau of Reclamation, Pacific Northwest Region; et al
E.I. Conference No.: 18621
Source: Water Resources Planning and Management and Urban Water Resources 1993. Publ by ASCE, New York, NY, USA. p 201-204
Publication Year: 1993
CODEN: 85MDAW ISBN: 0-87262-912-0
Language: English
Document Type: CA; (Conference Article) Treatment: A; (Applications); T ; (Theoretical); X; (Experimental)
Journal Announcement: 9309W1
Abstract: The Lower Colorado River Authority (LCRA) of Texas is both a water and energy supplier to a large area of Central Texas. LCRA generates approximately 10 percent of its power from hydroelectric power plants on the six dams in the Highland Lakes system of reservoirs. To improve power **production** , LCRA has investigated alternative operating procedures to increase the winter **scheduling** of hydroelectric power generation in the upper reservoirs of the Highland Lakes system without adversely impacting available water supplies. A methodology using both **optimization** and simulation techniques was developed to evaluate the ability of the hydroelectric facilities to meet weather-related winter peaking requirements. A **linear programming** procedure determined the hourly power generation **schedule** , over a 24 hour period, that maximized the total amount of power generated over the six hours of peak power demand. The full installed capacity was found to be available during the peak hours without **violating** system operating **constraints** including water storage limits at the individual lakes. Based on statistical simulation of daily winter inflows and releases using a LOTUS 1-2-3 spreadsheet, it was found that the full generating capacity could be supplied to meet the weather-related peak winter power demand with no significant impact on water availability. (Author abstract) 1 Ref.

12/7/2 (Item 1 from file: 103)
DIALOG(R)File 103:Energy SciTec

03530986 INS-93-016111; EDB-93-103467
Title: Impacts of hydropower operation on water supply from lower Colorado River in Texas
Author(s): Martin, Q.W. (Lower Colorado River Authority, Austin, TX (United States))
Title: Proceedings of the 20th anniversary conference: Water management in the '90s. A time for innovation
Author(s)/Editor(s): Hon, K. (ed.)

Conference Title: Conference on water management in the '90s: a time for innovation
Conference Location: Seattle, WA (United States) Conference Date: 1-5 May 1993
Publisher: New York, NY (United States) American Society of Civil Engineers
Publication Date: 1993 p 201-204 (907 p)
Report Number(s): CONF-9305209--
Language: English
Availability: American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017-2398 (United States)
Abstract: The Lower Colorado River Authority (LCRA) of Texas is both a water and energy supplier to a large area of Central Texas. LCRA generates approximately 10 percent of its power from hydroelectric power plants on the six dams in the Highland Lakes system of reservoirs. To improve power **production** , LCRA has investigated alternative operating procedures to increase the winter **scheduling** of hydroelectric power generation in the upper reservoirs of the Highland Lakes system without adversely impacting available water supplies. A methodology using both **optimization** and simulation techniques was developed to evaluate the ability of the hydroelectric facilities to meet weather-related winter peaking requirements. A **linear programming** procedure determined the hourly power generation **schedule** , over a 24 hour period, that maximized the total amount of power generated over the six hours of peak power demand. The full installed capacity was found to be available during the peak hours without **violating** system operating **constraints** including water storage limits at the individual lakes. Based on statistical simulation of daily winter inflows and releases using a LOTUS 1-2-3 spreadsheet, it was found that the full generating capacity could be supplied to meet the weather-related peak winter power demand with no significant impact on water availability.
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?t s16/7/all

16/7/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC

4883365 INSPEC Abstract Number: C9504-1290F-020
Title: A framework for case-based revision for schedule generation and reactive schedule management
Author(s): Miyashita, K.; Sycara, K.P.
Author Affiliation: Matsushita Electr. Ind. Co. Ltd., Osaka, Japan
Journal: Journal of Japanese Society for Artificial Intelligence vol.9, no.3 p.426-35
Publication Date: May 1994 Country of Publication: Japan
CODEN: JCGAED ISSN: 0912-8085
Language: Japanese Document Type: Journal Paper (JP)
Treatment: Theoretical (T); Experimental (X)
Abstract: We describe a unified framework for job shop **schedule optimization** in predictive and reactive contexts by **iterative** revision. The approach elicits user's context-dependent **scheduling** preferences in the form of cases through interaction with a user, and re-uses them to dynamically guide **schedule** revision decisions. The goals of the approach are: (1) correctness of the resulting **schedule** in the sense that there are no **violated constraints** ; (2) **optimization** of the modified **schedule** according to the user's input criteria and preferences; and (3) minimization of **schedule** disruptions in the reactive contexts. The methodology integrates case-based reasoning (CBR) mechanisms for incremental accumulation and reuse of past repair experiences that incorporate user preferences and **schedule** evaluation explanations, and **constraint** -based **scheduling** for propagation and resolution of the effects of repair. This framework is implemented in a system called CABINS. Experimental evaluation of CABINS as compared with other **scheduling** methods is given. (14 Refs)

16/7/2 (Item 2 from file: 2)
DIALOG(R)File 2:INSPEC

4630366 INSPEC Abstract Number: B9405-8110B-018, C9405-7410B-037
Title: Heuristic-based algorithms for enhancing interior point based OPF
Author(s): Momoh, J.A.; Lusaka, P.J.; Adapa, R.; Ogbuobiri, E.C.
Author Affiliation: Dept. of Electr. Eng., Howard Univ., Washington, DC, USA
Conference Title: Expert System Application to Power Systems IV Proceedings p.686-96
Editor(s): Dillon, T.S.
Publisher: CRL Publishing, Aldershot, UK
Publication Date: 1992 Country of Publication: UK xxix+723 pp.
ISBN: 0 646 12722 5
Conference Sponsor: NSF; EPRI; Applied Comput. Res. Inst
Conference Date: 4-8 Jan. 1993 Conference Location: Melbourne, Vic., Australia
Language: English Document Type: Conference Paper (PA)
Treatment: Practical (P)
Abstract: The goal of this paper is to implement a quadratic interior point method for optimal power flow. The scheme developed involves two-level **optimization** . Level 1 solves the quadratic or linear **optimization** problem subject to linear **constraints** , and Level 2 uses a

rule-based approach to **schedule** reactive power sources needed to minimize **constraint violations** . The algorithm has been evaluated on a 30-bus system. Its accuracy and speed are demonstrated. (9 Refs)

16/7/3 (Item 3 from file: 2)
DIALOG(R)File 2:INSPEC

04241554 INSPEC Abstract Number: B9211-8110B-010, C9211-7410B-006
Title: Application of the equivalent area model to multi-area generation scheduling with tie-line constraints
Author(s): Wang, C.; Shahidehpour, S.M.
Author Affiliation: Dept. of Electr. & Comput. Eng., Illinois Inst. of Technol., Chicago, IL, USA
Journal: International Journal of Electrical Power & Energy Systems vol.14, no.4 p.264-75
Publication Date: Aug. 1992 Country of Publication: UK
CODEN: IEPSDC ISSN: 0142-0615
U.S. Copyright Clearance Center Code: 0142-0615/92/40264-12$3.00
Language: English Document Type: Journal Paper (JP)
Treatment: Theoretical (T)
Abstract: A new method is proposed for solving the multi-area generation **scheduling** problem. The problem includes unit commitment and economic dispatch modules. The objective is to obtain an economic operation without **violating** various system **constraints** . This is a mixed integer-nonlinear **optimization** process. In the proposed method, an artificial neural network (ANN) is used to obtain the initial unit commitment **schedule** for every area, with the assumption that there are no transmission flows among areas. In order to get the minimum operation cost for the entire system while preserving **constrained** units, areas and tie-lines, an **iterative** procedure is used to coordinate unit combinations and energy dispatch **schedules** . An expert system is employed to modify the initial unit commitment pattern of each area by reducing the number of committed units to a minimum while satisfying the area **constraints** . (20 Refs)

16/7/4 (Item 4 from file: 2)
DIALOG(R)File 2:INSPEC

04203208 INSPEC Abstract Number: C9209-1290H-009
Title: An optimization **-based** heuristic **for vehicle routing and** scheduling **with soft time window** constraints
Author(s): Koskosidis, Y.A.; Powell, W.B.; Solomon, M.M.
Author Affiliation: City Coll., City Univ. of New York, NY, USA
Journal: Transportation Science vol.26, no.2 p.69-85
Publication Date: May 1992 Country of Publication: USA
CODEN: TRSCBJ ISSN: 0041-1655
U.S. Copyright Clearance Center Code: 0041-1655/92/2602-0069$01.25
Language: English Document Type: Journal Paper (JP)
Treatment: Theoretical (T)
Abstract: The vehicle routing and **scheduling** problem with time window **constraints** is formulated as a mixed integer program, and **optimization** -based **heuristics** which extend the cluster-first, route-second algorithm of Fisher and Jaikumar (1981) are developed for its solution. The authors present a new formulation based on the treatment of the time window **constraints** as soft **constraints** that can be **violated** at a cost and **heuristically** decompose the problem into an assignment/clustering component and a series of routing and **scheduling** components. Numerical

results based on randomly generated and benchmark problem sets indicate that the algorithm compares favorably to state-of-the-art local insertion and improvement **heuristics** . (40 Refs)

16/7/5 (Item 5 from file: 2)
DIALOG(R)File 2:INSPEC

03667171 INSPEC Abstract Number: C90047651
Title: Constraint **satisfiability algorithms for interactive student scheduling**
Author(s): Feldman, R.; Golumbic, M.C.
Author Affiliation: Dept. of Math. & Comput. Sci., Bar-Ilan Univ., Ramat Gan, Israel
Conference Title: IJCAI-89 Proceedings of the Eleventh International Joint Conference on Artificial Intelligence p.1010-16 vol.2
Editor(s): Sridharan, N.S.
Publisher: Morgan Kaufmann, Palo Alto, CA, USA
Publication Date: 1989 Country of Publication: USA 2 vol. (xxviii+xiv+1682) pp.
Conference Sponsor: Int. Joint Conferences on Artificial Intelligence; American Assoc. Artificial Intelligence
Conference Date: 20-25 Aug. 1989 Conference Location: Detroit, MI, USA
Language: English Document Type: Conference Paper (PA)
Treatment: Practical (P)
Abstract: A **constraint** satisfiability problem consists of a set of variables, their associated domains (i.e., the sets of values the variables can take) and a set of **constraints** on these variables. A solution to the CSP is an instantiation (or labeling) of all the variables which does not **violate** any of the **constraints** . Since **constraint** satisfiability problems are, in general, NP-complete, it is of interest to compare the effectiveness and efficiency of **heuristic** algorithms as applied to particular applications. The authors discuss ways to determine which algorithms perform best in solving the student **scheduling** problem (SSP) (the drawing up of students' timetables), and under what conditions. They also investigate the probabilistic techniques of B. Nudel (1983) for finding a near optimal instantiation order for search algorithms, and develop modifications which can yield a significant improvement in efficiency for the SSP. Finally, they assign priorities to the **constraints** and investigate **optimization** algorithms for finding **schedules** which rank high with respect to the priorities. Experimental results are reported. (13 Refs)

16/7/6 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)

03979465 E.I. No: EIP94112411519
Title: Logical framework for constraint **programming**
Author: Maruyama, Fumihiro; Minoda, Yoriko; Sawada, Shuho
Source: Fujitsu Scientific and Technical Journal v 30 n 1 June 15 1994. p 69-74
Publication Year: 1994
CODEN: FUSTA4 ISSN: 0016-2523
Language: English
Document Type: JA; (Journal Article) Treatment: A; (Applications); T; (Theoretical)
Journal Announcement: 9412W4

Abstract: This paper presents an approach to solving discrete **constraint** satisfaction or **optimization** problems, including LSI logic design, cutting-stock, and job-shop **scheduling** problems. The approach uses sufficient conditions for **constraint violation** , which we call 'nogood justifications' (NJs, for short), to prune the search space. NJs are represented as either inequalities or conjunctions of inequalities. Our results show that using NJs results in efficient pruning of the search space, **optimization** is over ten times faster than when using other approaches, and reexecution is accelerated considerably. (Author abstract) 11 Refs.

16/7/7 (Item 1 from file: 6)
DIALOG(R)File 6:NTIS

1674931 NTIS Accession Number: N93-18679/9/XAB
Rescheduling with Iterative Repair
Zweben, M. ; Davis, E. ; Daun, B. ; Deale, M.
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
Corp. Source Codes: 019045001; NC473657
May 92 5p
Languages: English
Journal Announcement: GRAI9311; STAR3106
In NASA. Ames Research Center, Working Notes from the 1992 Aaai Spring Symposium on Practical Approaches to Scheduling and Planning p 92-96.
NTIS Prices: (Order as N93-18659/1, PC A09/MF A02)
Country of Publication: United States
This paper presents a new approach to rescheduling called constraint-based iterative repair. This approach gives our system the ability to satisfy domain constraints, address optimization concerns, minimize perturbation to the original schedule, and produce modified schedules quickly. The system begins with an initial, flawed schedule and then iteratively repairs constraint violations until a conflict-free schedule is produced. In an empirical demonstration, we vary the importance of minimizing perturbation and report how fast the system is able to resolve conflicts in a given time bound. These experiments were performed within the domain of Space Shuttle ground processing.

16/7/8 (Item 1 from file: 108)
DIALOG(R)File 108:Aerospace Database

02112353 N93-25880
An optimal scheduling of pick-place operations of a robot-vision-tracking system by using neural networks and rule-based systems
Ph.D. Thesis
FENG, KEQI
Oklahoma State Univ., Stillwater.
CORPORATE CODE: OQ773281
1992 166P.
LANGUAGE: English
COUNTRY OF ORIGIN: United States COUNTRY OF PUBLICATION: United States
DOCUMENT TYPE: THESIS
DOCUMENTS AVAILABLE FROM AIAA Technical Library
OTHER AVAILABILITY: Univ. Microfilms Order No. DA9236738
JOURNAL ANNOUNCEMENT: STAR9309
In this research program, a **scheduling** of pick-place operations of a

robot-vison tracking system which handles multi-type and multi-size objects presented randomly on a moving conveyer has been identified and formulated as a real-time repetitive **optimization** problem. A mathematical model for calculating robot processing times in a **constrained** environment is constructed, and the strategy to deal with **constraint violation** situations is also proposed. The real-time repetitive optimization problem can be viewed as an associative mapping problem. A scheme which uses both the back-propagation and Hamming networks is proposed to implement the mapping in an attempt to overcome difficulties raised by using traditional methods. To improve the training time, an alternative neural network, a Modified ARTMAP (Adaptive Resonance Theory Networks), which is based on the ARTMAP introduced by Carpenter, et al. has been investigated to solve the optimal scheduling problem. The main modification is that a matching check mechanism is added to the system such that the Modified ARTMAP can cope with situations appearing in the optimal scheduling problem, whereas the original ARTMAP cannot, without using the complement coding technique. The repetitive optimization problem may also be viewed as an on-line decision making problem. A rule-based system can be constructed to conduct the on-line decision making directly is some rules are available. The discrimination net approach is designed for cases where all needed rules can be obtained; the partial search approach is designed for cases where only some of the rules are available. The **heuristic** approach is proposed for the cases of variable object patterns. Both neural network and ruled-based system approaches are implemented, and the experimental results have shown that time savings of up to 21 percent with only 4 different objects are possible, over first-come, first-served schemes currently used in industry (Dissert. Abstr.)

16/7/9 (Item 1 from file: 35)

01283408 ORDER NO: AADNN-73854

HYDRO-THERMAL OPTIMAL POWER FLOW SOLUTION FOR LARGE-SCALE ELECTRIC POWER SYSTEMS (POWER FLOW)

Author: ANGELIDIS, GEORGE ANGELOS

Degree: PH.D.
Year: 1991
Corporate Source/Institution: UNIVERSITY OF TORONTO (CANADA) (0779)
Source: VOLUME 53/12-B OF DISSERTATION ABSTRACTS INTERNATIONAL.
PAGE 6450. 160 PAGES
ISBN: 0-315-73854-5

This thesis presents a novel approach to the solution of the complex nonlinear problem of hydro-thermal Optimal Power Flow. The problem is solved **iteratively** , linearized at each major **iteration** . The linearized problem is decoupled into a primary and a secondary optimization stage.

The primary stage is a hydro-thermal generation scheduling problem, decomposed into a thermal and a hydro subproblem. The time coupling effect of the hydro system variables is thus eliminated from the thermal subproblem which is solved separately for each time period of the time horizon. It is a simple Economic Generation Scheduling problem that dispatches the thermal generators, minimizing the fuel cost subject to the Generalized Linear Power Balance **Constraint** and upper/lower bound **constraints** on active power generation. The hydro subproblem is solved by Network Flow Programming, maximizing the hydro generation benefit for the whole duration of the time horizon, subject to the complete set of hydro system **constraints** . The solutions of the thermal and hydro subproblems are adjusted by a hydro-thermal generation coordination algorithm.

The secondary stage is an optimization problem in the complete set of power system variables, minimizing the power system losses in each time period subject to all power system **constraints** . This problem is solved by sparse Linear Programming. Artificial equality **constraints** and penalty functions optimally adjust the active power generation in order to achieve feasibility. Additional step-limit **constraints** ensure that the solution is not far from that of the previous major **iteration** where the original problem is linearized. These **constraints** become progressively narrower as the overall method converges, thereby gradually enforcing coupling **constraints** that **violate** the assumptions of decoupling, and assuring the feasibility and optimality of the final solution.

The primary and secondary **optimization** subproblems are solved sequentially within each major **iteration** . Once the hydro-thermal generation **scheduling** algorithm converges, the hydro system variables are frozen and the problem is completely decomposed into distinct thermal subproblems, one for each time period. These subproblems are solved individually and sequentially in each major **iteration** , but they do not necessarily converge all at the same time.

16/7/10 (Item 2 from file: 35)

1066049 ORDER NO: AAD89-13181
A NEW HEURISTIC **ALGORITHM FOR RESOURCE-** CONSTRAINED **PROJECT SCHEDULING**
Author: HAN, JAEMIN
Degree: PH.D.
Year: 1988
Corporate Source/Institution: THE UNIVERSITY OF IOWA (0096)
SUPERVISOR: COLIN E. BELL
Source: VOLUME 50/04-A OF DISSERTATION ABSTRACTS INTERNATIONAL.
PAGE 1003. 109 PAGES

Scheduling decisions in a project **scheduling** problem are generally subject to both precedence and resource **constraints** . In the analysis of temporal **constraints** only, critical path calculations in PERT and CPM implicitly assume that limited resource availabilities would never be binding on **scheduling** decisions. In a general resource **constraint** which is expressed in terms of multiple units of each of several resource types, the resources demanded by concurrent activities at some time intervals may exceed the resource availabilities. Attempts to find an exact optimal solution to this multiple resource **constrained** **scheduling** problem have achieved mixed success and can generally cope with only moderate size projects. This relative lack of success of **optimization** procedures in realist problems motivated the development of **heuristic** solution methods which can generate reasonably good feasible solutions.

In this research, we describe a new **heuristic** solution method which attempts to fix resource conflicts by introducing new artificial arcs, called disjunctive arcs, into the network. Whenever a resource conflict with activities (a$\sb{\rm i}$, a$\sb{\rm j}$, ..., a$\sb{\rm k}$, a$\sb{\rm l}$) is recognized in the network of a project, one of the disjunctive arcs, $\{$(a$\sb{\rm i}$ $\to$ a$\sb{\rm j}$), ..., (a$\sb{\rm i}$ $\to$ a$\sb{\rm l}$), ..., (a$\sb{\rm l}$ $\to$ a$\sb{\rm k}$)$\}$, would be selected to be added to the network to resolve the conflict. Then the next resource conflict is found and resolved in the same way. The procedure is repeated until no resource conflict is found in the network. Performance of our solution method is compared with that of existing methods.

Our **heuristic** algorithm has two phases: (1) generation of a feasible

schedule by successively further **constraining** the network with additional arcs until no resource **constraint violations** remain and (2) use of limited search technique to find local improvements in the schedule found in stage 1.

No existing **heuristic** tested in previous research performed consistently best on the example problems. However, the new algorithm with a variation of the Resource Scheduling Method **heuristic** behaved better than any existing rules in the same test problems. Thus, the new algorithm is: (1) intuitively simple, (2) computationally inexpensive, (3) consistently effective, (4) compatible with AI automated planning/scheduling representations.

16/7/11 (Item 3 from file: 35)
DIALOG(R)File 35:Dissertation Abstracts Online

1064684 ORDER NO: AAD89-15154
THE WAREHOUSE SCHEDULING PROBLEM
Author: HARIGA, MONCER
Degree: PH.D.
Year: 1988
Corporate Source/Institution: CORNELL UNIVERSITY (0058)
Source: VOLUME 50/03-B OF DISSERTATION ABSTRACTS INTERNATIONAL.
PAGE 1093. 120 PAGES

We discuss the deterministic, infinite horizon, infinite production rate, infinite backorder cost, multi-item inventory stocking problem with a restriction on warehouse volume or floor space available. Our main goal is to determine a cyclic ordering pattern that minimizes the long run average ordering and holding costs per unit of time without **violating** the warehouse capacity **constraint** . We refer to the combined problem of order sizing and delivery **scheduling** for **optimizing** this system as the Warehouse **Scheduling** Problem, WSP.

We restrict attention to cyclic schedules that correspond to the delivery times with inventory runouts, the so-called Zero Switch Rule. We show that this rule is satisfied for any optimal cyclic schedule. Under this restriction, we formulate the WSP as a mixed integer nonlinear program. Due to the complexity of such a formulation, we decompose the WSP into different subproblems. For given order frequencies, we develop the Arbitrary Frequencies Bin Packing **Heuristic** which may be used for arbitrary integer frequencies to generate an order sequence. For a given sequence, we formulate a linear program to minimize the maximum storage space used. We show that its optimal solution is characterized by filling the warehouse at each order. We formulate the problem that minimizes the holding cost under the storage space **constraint** as a quadratic program and give conditions under which it has the same optimal solution as the linear program. When the lot sizes for multiple orders of each part are restricted to be equal, we devise an efficient algorithm to compute the optimal maximum space used. Finally, we integrate all the subproblem **heuristics** into an **iterative** algorithm to determine a good cyclic schedule. The algorithm compares favorably with all others in the literature in both solution quality and computational effort.

16/7/12 (Item 4 from file: 35)
DIALOG(R)File 35:Dissertation Abstracts Online

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OPTIMIZATION **BASED MODELS AND ALGORITHMS FOR ROUTING AND** SCHEDULING **WITH TIME WINDOW** CONSTRAINTS
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Source: VOLUME 49/09-A OF DISSERTATION ABSTRACTS INTERNATIONAL.
PAGE 2839. 282 PAGES

In this dissertation we deal with the development of models and algorithms for the Vehicle Routing Problem with Time Window **Constraints** based on a new class of algorithms, named global optimization based **heuristics** . The intrinsic difficulty of routing problems has prevented exact optimization algorithms from solving realistic size problems and thereby, **heuristic** algorithms have been the only alternative. Optimization based **heuristics** stand between the two extremes providing good quality solutions within reasonable computational requirements.

This research has been the first effort to develop and apply global **optimization heuristic** algorithms to the time window **constrained** VRP. First we develop a new relaxation based formulation for the VRP with time windows, which treats the time windows as "soft" **constraints** allowing their **violation** at a cost. The result is a more flexible model (compared to "hard" **constraints** models) which is less likely to get caught into local optima. Next we decompose the problem into a clustering component and a routing and **scheduling** component. In the clustering phase customers are partitioned into groups and a vehicle is assigned to service each group. In the routing and **scheduling** phase we seek for the optimal routing of vehicles.

Due to the complexity of the objective function of the problem the partitioning of customers is based on approximate clustering cost coefficients. An **iterative** scheme between the clustering phase and the routing and **scheduling** phase is employed to sharpen the approximation. Computational tests using randomly generated problems and benchmark problems have shown the superiority of the **optimization** based **heuristic** compared to local improvement **heuristics** .

Furthermore, we have studied and developed algorithms for the Capacitated Clustering Problem and the Traveling Salesman Problem with Soft Time Windows, which are the two prevailing components of the routing and scheduling problem.

As a final step, we used the global **optimization heuristic** to solve routing and **scheduling** problems phased by a major manufacturer. Compared to the routing **schedules** implemented in the field, the model has been found capable to provide significant support to the company's distribution management in a tactical, strategic and even operational level.

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1017649 ORDER NO: AAD88-15871
SOME PROBLEMS IN SEQUENCING AND SCHEDULING UTILIZING BRANCH AND BOUND ALGORITHMS
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Source: VOLUME 49/06-B OF DISSERTATION ABSTRACTS INTERNATIONAL.

This dissertation deals with branch and bound algorithms which are applied to the two-machine flow-shop problem with sparse precedence **constraints** and the optimal sequencing and **scheduling** of multiple feedstocks in a batch type digester problem. The common characteristic of these problems is that they are combinatorial **optimization** problems of the sequencing and **scheduling** class. Branch and bound methods are the natural approaches for these problems classes. The objective of this research is to derive efficient branch and bound algorithms for these problems.

An efficient solution of the problem with parallel-chain precedence **constraints** was developed by Kurisu in 1976. The problem studied here is to find a schedule which minimizes the maximum flow time with the requirement that the schedule does not **violate** a set of sparse precedence **constraints** . This research provides a branch and bound algorithm which employs a lower bounding rule and is based on an adjustment of the sequence obtained by applying Johnson's algorithm. It is demonstrated that this lower bounding procedure in conjunction with Kurisu's branching rule is effective for the sparse precedence **constraints** problem class.

Biomass to methane production systems have the potential of supplying 25% of the national gas demand. The production systems associated with this conversion process are anaerobic digestion facilities. The economic viability of these systems depends a great deal on cost effective production methods and facilities. The optimal operation of a batch digester system requires the sequencing and scheduling of all batches from multiple feedstocks during a fixed time horizon. A significant characteristic of these systems is that the feedstock decays in storage before use in the digester system. The operational problem is to determine the time to allocate to each batch of several feedstocks and then sequence the individual batches so as to maximize biogas production for a single batch type digester over a fixed planning horizon. This research provides a branch and bound algorithm for sequencing and a two-step hierarchical dynamic programming procedure for time allocation scheduling. An efficient **heuristic** algorithm is developed for large problems and demonstrated to yield excellent results.

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02163216 JICST ACCESSION NUMBER: 94A0458755 FILE SEGMENT: JICST-E

A Framework for Case-Based Revision for Schedule Generation and Reactive Schedule Management.

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Jinko Chino Gakkaishi(Journal of Japanese Society for Artificial Intelligence), 1994, VOL.9,NO.3, PAGE.426-435, FIG.8, TBL.1, REF.14
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ABSTRACT: We describe a unified framework for job shop **schedule optimization** in predictive and reactive contexts by **iterative** revision. The approach elicits user's context-dependent **scheduling** preferences in the form of cases through interaction with a user, and

re-uses them to dynamically guide **schedule** revision decisions. The goals of the approach are: (1) correctness of the resulting **schedule** in the sense that there are no **violated constraints** , (2) **optimization** of the modified **schedule** according to the user's input criteria and preferences, and (3) minimization of **schedule** disruptions in the reactive contexts. The methodology integrates case-based reasoning (CBR) mechanisms for incremental accumulation and reuse of past repair experiences that incorporate user preferences and **schedule** evaluation explanations, and **constraint** -based **scheduling** for propagation and resolution of the effects of repair. This frameworkis implemented in a system called CABINS. Experimental evaluation of CABINS as compared with other **scheduling** methods shows that the approach is able to (a) capture and effectively utilize user's **scheduling** preferences that were not present in the **scheduling** model, (b) outperforms other **scheduling** methods in both predictive **schedule** generation and reactive response to unpredictable execution time events along a variety of criteria that have been recognized as crucial in real operating environments. (author abst.)

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DIALOG(R)File 94:JICST-EPlus

01584198 JICST ACCESSION NUMBER: 92A0310557 FILE SEGMENT: JICST-E
Discrete constraint **satisfaction and optimization using sufficient conditions for** constraint violation.
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Joho Shori Gakkai Kenkyu Hokoku, 1992, VOL.92,NO.18(AI-81), PAGE.81.6,1-9, FIG.7, TBL.3, REF.10
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ABSTRACT: Many problems in design and **scheduling** can be formulated as discrete **constraint** satisfaction or **optimization** problems with **constraints** represented by inequalities and equalities. This paper presents a new approach to such problems. It uses sufficient conditions for **constraint violation** , which we call nogood justifications(NJs). An NJ is either an inequality or a conjunction of inequalities. NJs are generated and stored during execution and used to prune unexplored sub-trees of the search tree. To **optimize** an objective function, the algorithm **iteratively** applies itself to the corresponding **constraint** satisfaction problem. Experimental results show that(1) NJs enable us to drastically prune the search space. (2) The approach can **optimize** about a hundred times faster than other ones. (author abst.)

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01490536 JICST ACCESSION NUMBER: 92A0151092 FILE SEGMENT: JICST-E
Development of Plant Construction Scheduling Support System.
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, PAGE.58-68, FIG.11, TBL.4, REF.12
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ABSTRACT: A **scheduling** support system through knowledge-based man-machine cooperation has been developed for nuclear power plant construction. The proposed system, named NPCS, has three characteristic functions: (1) Automatic dissolution of **constraint violations** using a **constraint** -oriented programming technique; (2) Automatic resource leveling based on a combinatorial-**optimization** technique using **heuristic** rules on task ordering; (3) Display of a **scheduling** chart which facilitates interactive **schedule** modification performed by expert engineers. A **scheduling** process of NPCS consists of two steps. At thefirst step, an initial **schedule** with leveled resource is built, and at the second step, the initial **schedule** is improved interactively, where **constraint violations** are dissolved automatically. NPCS was experimentally applied to solve about 80 **scheduling** problems in a nuclear power plant construction and was confirmed to reduce the **scheduling** time and to improve the quality of the **schedule** . (author abst.)